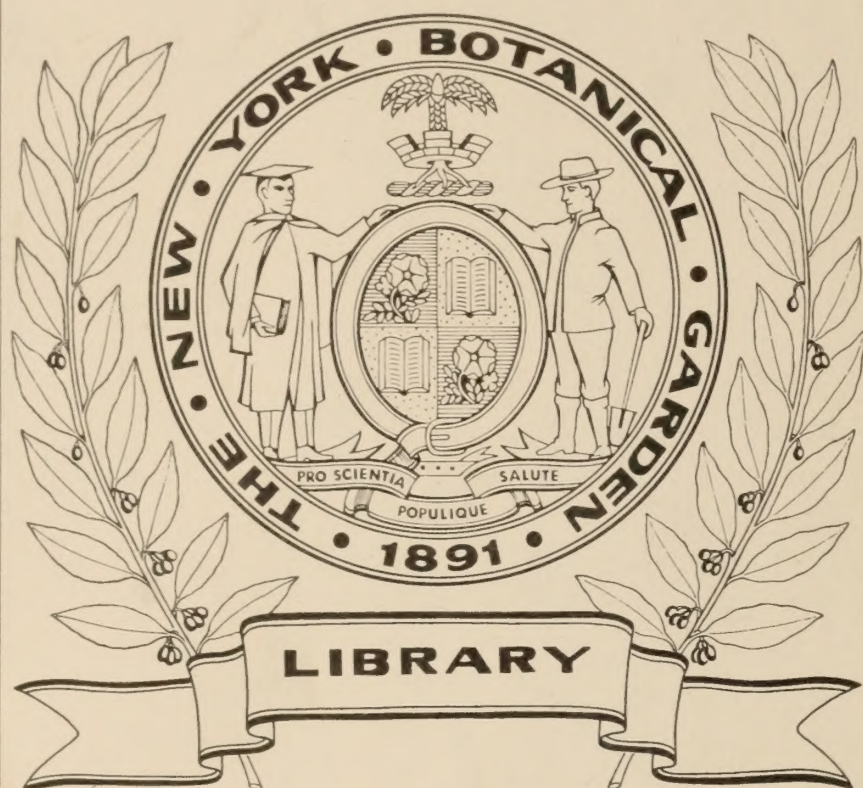


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1894/91



THE JOURNAL

OF THE

Cincinnati

Society of Natural History

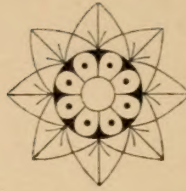
VOLUME XVII

PUBLISHED BY

THE CINCINNATI SOCIETY OF NATURAL HISTORY

NO. 108 BROADWAY, CINCINNATI, OHIO

1894-95



PUBLISHING COMMITTEE.

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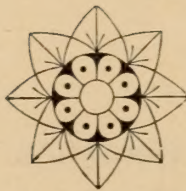


Table of Contents.

VOLUME XVII.

Proceedings,	I, 189
Annual Meeting,	1
Donations,	3, 193
Report of Director of Museum,	4
List of Corresponding Societies, etc.,	6
Programme Thirteenth Course Free Scientific Lectures,	17
Report of Treasurer,	18
Trustees' Report,	19
Report of Curator of Photography,	20
New Species of Fossils from the Hudson River Group, and Remarks upon Others. By S. A. Miller and C. L. Faber,	22
Biological Notes on Reared Parasitic Hymenoptera of Ohio and Indiana, with Descriptions of Thirteen New Species, by W. H. Ashmead. By F. M. Webster, M. Sc.,	34
The Petrified Forest of Arizona. By S. A. Miller,	56
The Granites of Cecil County, in North-eastern Maryland. By G. Perry Grimsley,	59, 78
Natural History Notes from North Carolina. Number Three. By A. G. Wetherby,	69
St. Peter's Sandstone. By Jos. F. James,	115
Description of Some Cincinnati Fossils. By S. A. Miller and C. L. Faber,	137
Studies of the Development of <i>Fidi viticida</i> Walsh, with Descriptions of One New Genus and Two New Species of Hymenoptera, by Wm. H. Ashmead. By F. M. Webster, M. Sc.,	159
The Preparation and Care of Insect Collections. By Chas. Dury,	173
An Account of the Chimpanzees (<i>Troglodytes Niger</i>) at the Cincinnati Zoological Garden. By Charles Dury,	181
Catalogue of the Odonata of Ohio. Part I. By D. S. Kellicott,	195
The Shaw Mastodon. An Examination and Description of Mastodon and Accompanying Mammalian Remains Found near Cincinnati, June, 1894. By Seth Hayes,	217
Photography: Its Possibilities in the Art-Field. A Lecture Before the Photographic Section. By Leon Van Loo,	227
Another Miami Valley Skeleton. Including a Description of Two Rare Harpoons. By Seth Hayes,	235

THE JOURNAL

- OF THE -

Cincinnati Society of Natural History.

VOL. XVII.

CINCINNATI, APRIL, 1894.

NO. I.

PROCEEDINGS.

April 3, 1894.

The regular Annual meeting of the Society was called to order at 8.05 P. M., with President Collier in the chair.

The minutes of December 5 were read and approved.

The name of G. W. Dittman was proposed for active membership, and his name ordered laid over for the usual length of time.

The names of F. B. Magill, F. M. Coppock and F. P. Goodwin were, upon motion, balloted for together and duly elected.

The reading of the minutes of the Executive Board for December 6, January 2, February 6 and March 6, was dispensed with.

The following resignations were read, and, upon motion, accepted, to-wit: C. A. Phipps, J. L. Krouse, Mrs. A. B. Thrasher, Mary L. Fisher, Gustave Bruhl, C. A. Parke, C. A. Stevens and T. J. Foy.

The report of the Treasurer having been called for, Mr. Davis L. James presented it for the year just closed. Upon motion, it was received, and ordered spread upon the minutes.

Upon motion, the chair appointed Mr. Chas. Dury, Dr. A. T. Keckeler and Mr. T. H. Kelley a special committee to audit the Treasurer's accounts.

The report of the Trustees, A. A. Ferris and Dr. P. M. Bigney, was read by the Secretary. It was received and ordered spread upon the minutes.

The report of Mr. H. J. Buntin, Curator of Photography, was also read by the Secretary, which, being received, was ordered spread upon the minutes.

The report of the Director of the Museum, Mr. Seth Hayes, was read, received and ordered spread upon the minutes.

The election of officers for the year 1894-5 was declared in order, whereupon nominations for President were called for. Dr. A. T. Keckeler presented the name of Mr. Davis L. James. Upon motion, the nominations were declared closed, and the Secretary was instructed to cast the unanimous ballot of the Society for Mr. James as President.

The chair then appointed Dr. Ricketts and Mr. Dury as tellers, whereupon the Secretary cast the ballot of the Society for Mr. James, and he was declared duly elected.

Being called to the chair, Mr. James, in a few words, thanked the Society for the honor conferred upon him.

Nominations for First Vice-President were called for, and Dr. A. T. Keckeler's name was presented by Mr. T. B. Collier. The same motions as in the case of the election of the President prevailing, the Secretary cast the unanimous ballot of the Society for Dr. Keckeler for First Vice-President, whereupon he was declared duly elected.

Dr. B. Merrill Ricketts was nominated to succeed himself as Second Vice-President; the usual motions prevailing, and the Secretary having cast the Society's ballot for him, he was declared elected.

For the position of Treasurer, Mr. T. B. Collier's name was presented, and after the usual motions and the ballot of the Society cast, he was elected.

Mr. T. H. Kelley was, after the same manner, re-elected to the office of Secretary.

Nominations for members of the Executive Board-at-large were made as follows, to-wit: Charles Dury, Dr. O. D. Norton, Prof. George W. Harper and Dr. F. W. Langdon. After the prevailing of the usual motions, the Secretary cast the unanimous ballot of the Society for these gentlemen, who were declared duly elected.

Dr. P. M. Bigney was nominated for Trustee, for a term of two years, to succeed himself, and was unanimously elected, the Secretary having cast the ballot of the Society for him, after the usual motions had prevailed.

For Librarian, Dr. M. Cassat was nominated for re-election, and was duly elected in the usual manner.

All the Curators of last year were re-elected as follows, to-wit:

Curator of Geology, E. O. Ulrich.

Curator of Botany, Davis L. James.

Curator of Zoology, Charles Dury.

Curator of Anthropology, Dr. O. D. Norton.

Curator of Photography, H. J. Buntin.

Curator of Microscopy, Dr. B. M. Ricketts.

Curator of Physics, no nomination.

Curator of Chemistry, Dr. A. I. Carson.

The donation of a goodly number of pamphlets, by Dr. Jas. A. Henshall, was announced.

The Society adjourned at 8.47.

DONATIONS.

Dr. Jas. A. Henshall, thirty-two pamphlets concerning the exhibits of various States and foreign countries at the World's Fair.

Mrs. A. J. Howe, steel portrait, framed, of the late Dr. A. J. Howe.

REPORT OF DIRECTOR OF MUSEUM.

CINCINNATI, April 3, 1894.

OFFICERS AND MEMBERS OF THE CINCINNATI SOCIETY OF
NATURAL HISTORY.

Ladies and Gentlemen — In the preparation of this, the second annual report of the undersigned, as Director of the Museum, it is evident that a different class of work has been in hand during the last twelve months, than the previous year, although the same end has always been before us — to keep the property of the Society free from the ravages of dirt and dermestes, and to place and classify the various collections, so as to be more available to the student.

The large collections of minerals have been combined and classified—a long stride toward a final arrangement of the specimens into a carefully-labeled, systematic series.

The plaster casts of the mastodon, glyptodon, and dinothorium have been repaired, so as to be more presentable. The curiosity of the casual visitor to the Museum is evidently highly developed, the free use of pen-knives, umbrellas, and canes in former years, being manifest in the different departments. Especially was it true of these casts, which were not only chipped, but broken by these various instruments of destruction.

The library has been the especial care of the year. The bound volumes having been classified and arranged, while the pamphlets have been carefully sorted, preparatory to binding. The exchange list has been changed to some extent by the addition of new and valuable publications, and the discontinuance of some that were of no value to us. A full list of the exchanges and correspondents is attached hereto and made a part of this report.

The thirteenth course of free scientific lectures is now in progress, seven having been delivered, the three remaining being announced for this month and next. The attendance

has been, on the whole, somewhat larger than last season, but not at all regular; the largest audience numbering 196 persons. A programme of the course is attached to and forms a part of this report.

Recently facilities have been provided for the lighting of the entire Museum, consequently, upon evenings announced for gatherings of the Society, the Museum is open from 7 to 8 o'clock.

Four thousand one hundred and fifty-eight persons have visited the Museum during the year. The largest month being May, 1893, with 614 visitors; while Wednesday, November 1, 1893, bears the palm of any single day, with 224 visitors. Since September 1, 1893, 2,599 visitors have registered, as against 2,680 for a like period last year.

The number of visitors to the Museum on Sundays did not justify the Sunday opening, hence, the trial has not been made a permanent feature.

In accordance with our recommendation, a successful effort was made to revive the work among the young people—The Cincinnati Lyceum of Natural History. The initiatory meeting was held November 4, 1893, with an attendance of nineteen. These meetings are held every Saturday morning, and the elementary work is made as practical as possible, while field excursions will constitute the bulk of the Spring programme. For the special benefit of the High School pupils, dissections were made of the circulatory (injected specimen), respiratory, and nervous systems of the dog and cat. Out of a membership of twenty-eight, the regular attendance has been twenty-five, a sure sign of the interest taken in the work by the members. At an illustrated lecture by the Director, on "Some Microscopic Animals," seventy-two persons were present, while sixty-six attended the talk on "Nervous Systems of Vertebrates." It is the desire of the management, whose success depends on your assistance, to show a decided gain in this department another year.

The Society assisted the State authorities with their Anthropological and Angling Exhibits at the Columbian Exposition, by giving the Director's time and the loan of a typical collection from the pre-historic cemetery near Madisonville, and a series of the smaller fishes from the streams of this county.

All the material so loaned has been returned to the Society in good condition.

The Society is in a position to do much more than has ever been done for the cause of Science. This certainly can not be done by an "inner circle," a certain few of "the faithful." May not each and every member put his shoulder to the wheel and help. Locally, we must be advertised, as never before. The best way to do this is to tell our friends and neighbors of our Society, and what we are doing. In short, to "talk the Society," and bring in new active members. Abroad, we are judged by our journal—as a Society, whether dead or alive, by the Proceedings published therein. Should it, then, not be the duty of every member to attend the meetings, and bring in papers and material for discussion?

We are prepared to better work than ever before, and by united effort it will surpass our fondest hopes.

Respectfully submitted,

SETH HAYES,

Director of the Museum.

LIST OF CORRESPONDING SOCIETIES, ETC.

UNITED STATES.

ALABAMA.

University.

Geological Survey of Alabama.

ARKANSAS.

Arkansas Geological Survey (see Stanford University, Cal.)

CALIFORNIA.

San Diego.

West American Scientist.

San Francisco.

California Academy of Sciences.

California State Mining Bureau.

Technical Society of the Pacific Coast.

Leland Stanford, Jr., University.

Prof. J. C. Branner, for Ark. Geol. Surv.

COLORADO.

Colorado Springs.

Colorado College Scientific Society.

Denver.

Colorado Scientific Society.

CONNECTICUT.

Meriden.

Meriden Scientific Association.

New Haven.

American Journal of Science.

Connecticut Academy of Sciences.

Connecticut Agricultural Experiment Station.

DISTRICT OF COLUMBIA.—Washington.

American Monthly Microscopical Journal.

Anthropological Society.

Biological Society of Washington.

Department of Agriculture.

Bureau of Animal Industry.

Division of Botany.

Division of Chemistry.

Division of Economic Ornithology and Mammalogy.

Division of Entomology (Insect Life).

Division of Forestry.

Division of Microscopy.

Division of Pomology.

Office of Experiment Stations.

Secretary and Statistician.

Section of Vegetable Pathology (Journal of Mycology.)

Weather Bureau.

Department of the Interior.

Bureau of Education.

United States Geological Survey.

National Academy of Sciences.

Smithsonian Institution.

United States National Museum.

Bureau of Ethnology.

United States Fish Commission.

United States Naval Observatory.

War Department.

Surgeon General's Office.

ILLINOIS.

Champaign.

State Laboratory of Natural History.

Chicago.

University of Chicago Press (Journal of Geology).

Good Hope.

American Antiquarian.

Springfield.

Illinois State Museum of Nat. Hist. (Illinois Geol. Surv.)

INDIANA.

Bloomington.

Botanical Gazette.

Brookville.

Indiana Academy of Sciences.

Indianapolis.

State Geological Survey.

IOWA.

Ames.

Iowa Agricultural College.

Davenport.

Davenport Academy of Sciences.

Des Moines.

Iowa Academy of Sciences.

Iowa City.

University of Iowa.

KANSAS.

Lawrence.

Kansas University Quarterly.

Manhattan.

Kansas State Agricultural College (Agri. Experi. Station).

Topeka.

Kansas Historical Society.

Washburn College Laboratory.

KENTUCKY.

Frankfort.

Kentucky Geological Survey.

Lexington.

Kentucky Agricultural Experiment Station.

LOUISIANA.

New Orleans.

New Orleans Academy of Science.

MARYLAND.

Baltimore.

Johns Hopkins University.

Maryland Academy of Sciences.

MASSACHUSETTS.

Boston.

American Academy of Arts and Sciences.

Boston Society of Natural History.

Massachusetts State Board of Agriculture.

Cambridge.

Cambridge Museum of Comparative Zoölogy.

Peabody Museum of Archæology and Ethnology.

Psyche.

Hyde Park.

Ornithologist and Oologist.

Salem.

American Association for the Advancement of Science.

Wood's Hall.

Marine Biological Laboratory.

MICHIGAN.

Agricultural College.

Michigan State Agricultural College.

MINNESOTA.

Minneapolis.

American Geologist.

Minnesota Academy of Natural Sciences.

Minnesota Geological and Natural History Survey.

MISSOURI.

Jefferson City.

Geological Survey of Missouri.

St. Louis.

St. Louis Academy of Natural Sciences.

NEBRASKA.

Lincoln.

University of Nebraska (University Studies).

NEW JERSEY.

New Brunswick.

Geological Survey of New Jersey.

Trenton.

New Jersey Natural History Society.

NEW YORK.

Albany.

Albany Institute.

Hall, Prof. James.

Natural History of New York (State Library).

New York Museum.

Buffalo.

Buffalo Historical Society.

Geneva.

New York Experiment Station.

New York City.

American Gardening.

American Geographical Society.

American Museum of Natural History.

Auk, The.

Comparative Medicine and Surgery Journal.

Linnean Society of New York City.

New York Academy of Sciences.

New York Microscopical Society.

Popular Science News.

Torrey Botanical Club.

Poughkeepsie.

Vassar Brothers' Institute.

Rochester.

Rochester Academy of Science.

NORTH CAROLINA.

Chapel Hill.

Elisha Mitchell Scientific Society.

OHIO.

Cincinnati.

Public Library.

University of Cincinnati (Cincinnati Observatory).

Young Men's Christian Association.

Columbus.

Archæologist, The.

OHIO, Columbus.—Continued.

Columbus Horticultural Society.

Ohio State Board of Agriculture.

Granville.

Denison Scientific Association (Denison University).

Journal of Comparative Neurology.

Wooster.

Ohio Agricultural Experiment Station.

PENNSYLVANIA.

Philadelphia.

Academy of Natural Sciences.

American Naturalist.

American Philosophical Society.

Entomological News.

Nautilus, The.

Pennsylvania Geological Survey.

Wagner Free Institute of Science.

Zoölogical Society of Philadelphia.

RHODE ISLAND.

Newport.

Newport Natural History Society.

TEXAS.

Austin.

Geological Survey of Texas (Department of Agriculture, Insurance, Statistics, and History).

VIRGINIA.

Charlottesville.

Leander McCormick Observatory (University of Va.)

WEST VIRGINIA.

Charleston.

West Virginia Agricultural Experiment Station.

WISCONSIN.

Madison.

State Historical Society.

Wisconsin Academy of Science, Arts, and Letters.

Milwaukee.

Natural History Society of Wisconsin.

Public Museum.

CANADA.

Halifax.

Nova Scotia Institute of Natural Sciences.

London.

Canadian Entomologist.

Montreal.

Canadian Record of Science.

Ottawa.

Canadian Geological and Natural History Survey.

Ottawa Field Naturalists' Club (Ottawa Naturalist).

St. John.

Natural History Society.

Toronto.

Canadian Institute.

Winnipeg.

Manitoba Historical and Scientific Society.

MEXICO.

City of Mexico.

Deutschen Wissenschaftlichen Vereins in Mexico.

Museo Nacional de Mexico.

Sociedad Mexicana de Historia Natural.

Sociedad Cientifica, "Antonio Alzate."

COSTA RICA.

San Jose.

Museo Nacional.

ARGENTINE REPUBLIC.

Buenos Ayres.

Argentina Historia Natural.

Cordova.

Academia Nacional de Ciencias.

BRAZIL.

Rio de Janeiro.

Museo Nacional.

CHILI.

Santiago.

Deutschen Wissenschaftlichen Vereins in Santiago.

Societe Scientifique du Chili.

PHILIPPINE ISLANDS.

Manila.

Compania de Jesus.

ENGLAND.

Bristol.

Bristol Naturalists' Society.

London.

Geological Society of London.

Royal Microscopical Society.

Manchester.

Manchester Literary and Philosophical Society.

Penzance.

Royal Geological Society of Cornwall.

SCOTLAND.

Edinburgh.

Botanical Society.

Edinburgh Geological Society.

Royal Society.

Royal Physical Society.

Royal College of Physicians.

Glasgow.

Natural History Society.

FRANCE.

Nantes,

Societe des Sciences Naturelles, etc.

Paris.

Societe Entomologique de France.

Societe Zoölogique de France.

Toulouse.

Academie des Sciences, Inscriptions et Belleslettres.

GERMANY.

Augsburg.

Augsburg Naturhistorischen Verein.

Berlin.

Botanischen Verein der Provinz Brandenburg.

Braunschweig.

Braunschweig Verein für Naturwissenschaft.

GERMANY.—Continued.

Bremen.

Bremen Naturwissenschaftlichen Verein.

Cassel.

Cassel Verein für Naturkunde.

Frankfort-on-Oder.

Societatum Literæ Natur Verein des Reg Bez.

Giessen.

Oberhessische Gessellschaft für Natur und Heilkunde.

Halle.

Kaiser Leop - Carol Deutschen Akademie der Natur-
forschen.

Kassel.

Vereins für Naturkunde zu Kassel.

Leipsig.

Verein für Erdkunde.

Munster.

Westfalichen Provinzial Verein für Wissenschaft und
Kunst.

Stuttgart.

Verein für Vaterländische Naturkunde in Wurttemberg.

AUSTRIA.

Vienna.

Kaiser König Geologischen Riechanstalt.

K. K. Naturhistorichen Hofmuseum.

RUSSIA.

Kiew.

Kiew Societe des Naturalistes.

Moscow.

Societe Imperiale des Naturalistes de Moscou.

St. Petersburg.

Comite Geologique de Russie.

SPAIN.

Barcelona.

Barcelona Academia di Ciencias y Artes.

SWITZERLAND.

Basel.

Basel Naturforschenden Gesellschaft.

Bern.

Bern Naturforschenden Gesellschaft.

Geneve.

La Societe Botanique Suisse.

Lausanne.

Societe Vaudoise des Sciences Naturelles.

Zurich.

Naturforschenden Gesellschaft.

Schweizenschen Botanischen Gesellschaft.

BELGIUM.

Brussels.

Societe Royale Malacologique.

HUNGARY.

Budapest.

Ethnologische Mittheilungen aus Ungarn.

Trencsin.

Natural History Society of Trencsin.

SWEDEN.

Stockholm.

Institute Royale Geologique de la Suede.

Kongl. Swenska Vetenskaps Akadamiens Handlingar.

Kongl. Vetenskaps Akadamiens Forhandlingar.

Societe Entomologique a Stockholm.

ITALY.

Naples.

Societe Africana d' Italia.

Pisa.

Societa Toscana di Scienza Naturali.

Rome.

Ministero di Agricoltura, Industria e Commercio.

Turin.

Torino Musei di Zoölogica ed Anatomia Comparata.

HOLLAND.

Leiden.

Netherland Zoölogical Society.

NORWAY.

Christiana.

Royal University of Norway.

SYRIA.

Beyrouth.

Revue Internationale de Bibliographie.

INDIA.

Calcutta.

India Geological Survey.

India Survey Department.

AFRICA.

Cape Town.

South African Philosophical Society.

AUSTRALIA.

Adelaide.

Royal Society of South Australia.

Melbourne.

Victoria Public Library, Museum, and National Gallery.

Sydney.

Linnean Society.

Hon. Minister of Mines, Department of Mines.

Royal Society.

JAPAN.

Tokio.

Deutschen Gesellschaft für Natur und Volkerkunde
Ostaiiens.

Japan Imperial University.

PROGRAMME.

THIRTEENTH COURSE OF FREE SCIENTIFIC LECTURES—1894.

THURSDAY, January 4.—Bacteriology. Illustrated by lantern slides. S. P. Kramer, M. D., Cincinnati Medical College.

THURSDAY, January 18.—Fertilization, and its Bearing upon Current Theories of Heredity. Illustrated by original drawings. E. G. Conklin, Ph. D., Biological Department, Ohio Wesleyan University, Delaware.

THURSDAY, February 1.—My Ascent of Mt. Blanc. Illustrated by lantern slides. Wm. Hubbell Fisher, Cincinnati Society of Natural History.

THURSDAY, February 15.—Wheel Animalcules. Illustrated by lantern slides. D. S. Kellicott, Ph. D., Department of Entomology and Comparative Anatomy, Ohio State University.

THURSDAY, March 1.—The Procession of Life, a Geological Study. Illustrated by lantern slides. E. W. Claypole, B. A., D. Sc., Professor of Geology, Buchtel College, Akron.

THURSDAY, March 15.—Pre-Columbian Americans in Light of Recent Discoveries. Illustrated by lantern slides. Warren K. Moorehead, Curator of Anthropology, Ohio State University.

THURSDAY, March 29.—Man's Work in Defense of Plants. Illustrated by lantern slides. Joseph F. James, M. Sc., Assistant Pathologist, United States Department of Agriculture, Washington.

THURSDAY, April 12.—Various Kinds of Eyes—Their Uses and Abuses. Illustrated by lantern slides. Joseph V. Ricketts, M. D., Cincinnati.

THURSDAY, April 26.—Some Interesting Ants. George K. Morris, D. D., Pastor St. Paul M. E. Church, Cincinnati.

THURSDAY, May 10.—The Physiology of Plants. George B. Twitchell, M. D., Miami Medical College, Cincinnati.

REPORT OF TREASURER OF THE CINCINNATI SOCIETY
OF NATURAL HISTORY, FOR THE YEAR
ENDING APRIL 3, 1894.

TO PRESIDENT AND MEMBERS OF CINCINNATI SOCIETY OF
NATURAL HISTORY:

Your Treasurer appends hereto a statement of receipts and expenditures for the year just closed, showing a cash balance in the treasury of \$329.90.

The interest on the endowment funds of the Society has been paid with reasonable promptness, and in full to date.

The Treasurer, as authorized by the Board, has paid interest on the following of the Society's outstanding notes, viz:

On five per cent notes Nos. 1, 2, 3, 4, 5, 6, 9, 10, 12, 13, 14, 15, 16, 17, 18 (15 out of 18).

On six per cent notes Nos. 7, 8, 9, (all now out) amounting to \$98.00.

Of these notes there are outstanding eighteen at five per cent and three at six per cent, amounting to twenty-one hundred dollars. The first of these become due June, 1896. Some provision should be made to meet them as they become due.

All of which is respectfully submitted.

DAVIS L. JAMES, *Treasurer.*

RECEIPTS 1893-94.

Interest,	\$2,678 89
Dues,	522 00
Journal,	5 00
Balance, April, 1893,	188 13
	<hr/>
	\$3,394 02

EXPENDITURES 1893-94.

Salaries and labor,	\$1,554 00
Journal,	455 25
Contingent expenses (custodian's sundries),	212 39
Printing and stationery,	56 30
Photographic section (postages, printing and stove), .	105 93
Fuel,	196 00
Interest,	98 00
Lectures,	97 87
Museum,	18 25
Water rent,	25 00
Gas,	20 40
Repairs and cleaning,	88 56
Fixtures,	88 60
Ice,	6 40
Alcohol,	24 87
Postages, Treasurer and Journal,	4 30
Street sprinkling,	12 00
	<hr/>
	\$3,064 12
Balance cash,	329 90
	<hr/>
	\$3,394 02

SUMMARY—RECEIPTS.

Balance, April 4, 1893,	\$188 13
Receipts, all sources,	3,205 89
	<hr/>
	\$3,394 02

PAYMENTS.

Expenditures,	\$3,064 12
Balance,	329 90
	<hr/>
	\$3,394 02

TRUSTEES' REPORT.

CINCINNATI, OHIO, April 3, 1894.

TO THE BOARD OF DIRECTORS OF THE CINCINNATI
SOCIETY OF NATURAL HISTORY:

Gentlemen — The undersigned, Trustees of the Society, beg leave to submit their annual report for the year ending April 2, 1894, and state that there has been no change in the investments of the funds of the Society, as shown by the report of April 4, 1893, except in this, to-wit:

The Joseph M. Story loan of \$1,000 was paid in April last, and soon thereafter the Trustees loaned the same to Stephen H. Wilder, a thoroughly responsible party, on a demand loan, secured by collateral.

The loan to Dr. Henry Snow of \$2,000 was paid in July last, and was re-invested in August by a loan to Frederick A. Schmidt, and secured by a mortgage on real estate.

One of the loans to Hester V. Froome, that in the sum of \$3,000, was paid in January, and is still uninvested, awaiting a desirable party with approved security.

These are the only changes in the funds of the Society made since our last report.

The Trustees have thought best to indulge the Blymyers on their loan, the interest having been paid. The Trustees have no concern as to the safety of the loan, the security being ample. They expect, however, that this loan will be paid off and re-invested within a short time.

The interest of all of the Society's investments has been paid with reasonable promptness, and the notes are all in a satisfactory shape.

Respectfully submitted,

AARON A. FERRIS,

P. M. BIGNEY,

Trustees.

REPORT OF CURATOR OF PHOTOGRAPHIC SECTION.

CINCINNATI, April 3, 1894.

TO THE CINCINNATI SOCIETY OF NATURAL HISTORY:

As Curator of Photography, I hereby submit the following report for the year just ended:

The Photographic Section has lost largely in membership, beginning the year with a roll of 113 members and ending with 69 active and one honorary.

The reasons for this decrease are many: First, a general falling off everywhere in interest in the subject of amateur photography; second, hard times; third, misunderstandings as to the matter of dues.

The Photographic Section made their Annual Outing on the 30th of May, to the vicinity of Morrow, Warren County, Ohio. The day was a great success socially, and a large number of members and their friends took advantage of the occasion to spend a few hours in the woods and fields. Some excellent photographic work was done.

The Annual Exhibition of lantern slides has not yet been held, but has been fixed for Friday evening, April 27, 1894, and the prospects for a good exhibition are very promising.

It is my duty to report that a number of articles in the way of apparatus have mysteriously disappeared from the operating rooms of the Section during the past year, and some system of oversight should be inaugurated by the Directors.

The recommendation that the constitution or rules of the Society should be so changed as to allow the prorating of dues is also submitted.

When a new member joins the Society he should not be charged for that portion of the year which is past. This very rule has been the cause of more dissatisfaction and the loss of more members than anything else I know of.

To be of any service to the members of the Photographic Section, the operating rooms should be kept clean and warm at all times.

In conclusion, I will add that while the membership has fallen off and the general interest in the art has declined, there has been more good work done in photography the past year than ever before in the same period of time.

Respectfully submitted,

H. J. BUNTIN,
Curator Photographic Section.

NEW SPECIES OF FOSSILS FROM THE HUDSON RIVER GROUP, AND REMARKS UPON OTHERS.

BY S. A. MILLER AND C. L. FABER.

ORTHODESMA CYLINDRICUM, n. sp.

Plate 1, Fig. 1, left side of a good specimen; Fig. 2, left side of another specimen; Fig. 3, dorsal view of the same; Fig. 4, dorsal view of a smaller specimen somewhat injured.

Shell above medium size, four to five times as long as wide; cardinal and basal lines posterior to the beaks, straight and parallel to near the posterior end, which is obliquely rounded, with the greatest extension at the postero-basal angle or limit of the umbonal slope. Sides rounded posterior to the beaks and very gently flattened toward the posterior end. Anterior end gently contracted, forward of the beaks, and curved slightly downward and rounded at the extremity. Beaks small and extending beyond the cardinal line, so as to come nearly in contact with each other, and terminating between one-fourth and one-fifth of the length of the shell from the anterior end. The umbones are compressed in all our specimens. The sulcus below the umbonal ridge, that usually forms a conspicuous character in this family of shells, is undefined and scarcely to be distinguished in some specimens.

Surface marked by concentric lines of growth, which are strongest and best defined near the hinge of the shell.

This species has some resemblance to *O. curvatum* and *O. rectum*; but it is much longer in proportion to its height than either of them, and more uniformly rounded, beside being wholly different from each of them anterior to the beaks.

It occurs above the middle part of the Hudson River Group, in Warren County, Ohio, and is in the collection of both the authors of this article.

BODMANIA, n. gen.

[This genus is dedicated to Mr. Charles Bodman, who contributed fifty thousand dollars to the Cincinnati Society of Natural History.]

Equivalve, profoundly inequilateral; ventricose; general outline resembling *Cypricardites*; beaks at the anterior end incurved over the cardinal line; hinge line short and at a very high angle to the base of the shell; ligament external; shell thin; concentrically lined or smooth. The casts show no muscular scars and the hinge line is unknown, but, evidently, there are no lateral teeth, and, probably, no teeth beneath the beaks. The absence of muscular scars, position of the cardinal line and external ligament ally this genus with *Sphenolium*, while the general outline and umbonal slopes give it the appearance of *Cypricardites*. Type B. insuetum. This genus will include the form described by Hall as *Edmondia ventricosa*, in Pal. N. Y., Vol. I, p. 155, from the Trenton Group of New York, and which has been generally referred to *Cypricardites*, or *Palæarca*.

BODMANIA INSUETUM, n. sp.

Plate 1, Fig. 5, left side view; Fig. 6, right side view of the same specimen; Fig. 7, anterior end view of the same.

Shell short, subelliptical in outline, ventricose in front and in the umbonal region, and cuneate toward the base and posterior end. Hinge line short, straight, and at an angle from the basal line of about fifty degrees, from the posterior end of which the shell is slightly winged, giving to the shell the greatest height posterior to the end of the hinge line. The posterior end is subtruncate or moderately rounded, the basal margin is very broadly rounded. The anterior end is subcordiform. Beaks pointed and incurved beyond the hinge line at the anterior end. Shell thin and probably concentrically lined, though the part preserved on the specimen

illustrated is smooth. Muscular scars so delicate as not to appear on the casts. In its general outline, it resembles a *Cypricardites*, but the absence of muscular scars and the short, highly-inclined cardinal line at once distinguish it. It has some resemblance to the fossil described as *Edmondia ventricosa* (N. Y. Pal., Vol. I, p. 155), and generally referred to as *Cypricardites ventricosus*, which is a smaller shell, more prolonged in the postero-basal part, giving it a rhomboidal outline, and is higher in the umbonal region. It is certain that *Edmondia ventricosa* does not belong to *Edmondia* or *Cypricardites*, and it agrees with this genus in the highly inclined cardinal line, and in showing no muscular scars in the casts.

This species occurs in the upper part of the Hudson River Group, at Richmond, Indiana. The specimen illustrated is from the collection of C. L. Faber.

AMBONYCHIA CINCINNATIENSIS, n. sp.

Plate 1, Fig. 8, left valve of an old specimen; Fig. 9, hinge of the same specimen injured at the distal end of the lateral teeth; Fig. 10, hinge and lateral teeth of the left valve of a younger and smaller shell.

Shell below the medium size, and more or less subacutely ovate in outline, varying a little in the extent of the wing bearing the lateral teeth in the different specimens. Posterior side only slightly winged and rounding into the base below. Anterior border of the valves truncated below the beaks, where there is a moderately large byssal opening, and below this the valves very gently round into the base. Base evenly rounded. Umbones low, subangular, below which the valves are depressed convex. Beaks slightly incurved, pointed, terminal and extending beyond the cardinal teeth and hinge line. Surface marked by tolerably fine radiating striæ and occasional concentric lines of growth.

This species has been generally referred to *Ambonychia bellistriata*, a New York Trenton form, but there is a wide difference between the two species. *A. bellistriata* is much

more alate, the striæ are finer, the umbones more convex, and beaks more distinctly incurved and pointed.

We have figured the hinge line of two specimens for the purpose of showing that the cartilage grooves from the cardinal teeth to the lateral teeth increase in number with the size and age of the shell. Fig. 10 represents a thinner and smaller shell than Fig. 9, and it has only two cartilage grooves, while the specimen represented by Fig. 9 has four cartilage grooves. This is a character noticed by one of the authors in describing *Anomalodonta gigantea*, where the number of lateral cartilage grooves varied in the specimens examined from four to eighteen. It is probable that the number of cartilage grooves increase with age in all the genera belonging to the Ambonychiidæ.

This species occurs in the lower part of the Hudson River Group, at Cincinnati. The specimens illustrated are from the collections belonging to the authors.

PTERINEA CINCINNATIENSIS, n. sp.

Plate 1, Fig. 11, the convex valve of a large specimen; Fig. 12, the opposite valve of the same specimen; Fig. 13, the convex valve of another specimen having the wings better preserved; Fig. 14, the convex valve of a smaller specimen; Fig. 15, the opposite valve of the same; Fig. 16, the convex valve of a very small specimen; Fig. 17 the opposite valve of the same.

The first thing to which the attention should be directed in the examination of this species, is the great diversity in the size of the specimens collected. This we attribute to age, the smaller specimens we regard as the young shells and the larger ones as the mature forms. The surface markings of the shells are the same, and the only differences noted in the shape of the specimens, is that the wings become proportionally more extended with the growth of the shells.

Shell oblique, subrhomboidal in outline, with the basal margin rounded and the posterior side contracted below the point of the wing. Left valve depressed, convex in the central part, and flattened toward the alations; right valve

nearly flat, though slightly convex in the umbonal region; hinge line straight, longer than the body of the shell, though not equal to the height; anterior wing short, extending, however, in the older shells somewhat acutely beyond the margin of the shell; posterior wing triangular, extending in mature forms as far as the body of the shell, and terminating in an acute point; surface of the left valve marked by concentric striæ that become more and more distant from each other from the beak to the base. There are no longitudinal radii or lines. Surface of the right valve smooth, except a series of wrinkles on each wing are directed obliquely from the cardinal line toward the body of the shell, but fade away at the sulci.

This species has been generally classed with *Pterinea insueta* of the Utica Slate of New York, but the shells are quite different in form, especially in the shape of the anterior wing, and also in the surface ornamentation. There are longitudinal radiating striæ along the middle of *Pterinea insueta*, none of which exist in this species, and the concentric markings on *P. insueta* consist of finer and coarser striæ and wrinkles, while on this species the concentric striæ are smooth, of uniform size, and become more and more distant from each other as they approach the base of the shell. *Pterinea insueta* is not known to occur in the rocks in the vicinity of Cincinnati, and so far as we are informed, it is confined to the Utica Slate of New York.

This species is not rare in the middle part of the Hudson River Group, especially at the stone quarries on the hills about Cincinnati. The specimens illustrated are from the collections belonging to the authors.

PTERINEA RUGATULA, n. sp.

Plate 1, Fig. 18; view of the left valve of a large specimen, having some of the margin broken away; Fig. 19, view of the left valve of a smaller and more perfect specimen.

Shell below medium size, oblique, subrhomboidal; body, without the wings, oblique-ovate, hinge line straight, about

equal to the greatest length of the shell, but shorter than the height of the shell. Anterior, posterior, and basal margins rounded below the wings. Left valve rather highly and broadly convex, umbonal region prominent and distinctly defined by the sulcus separating it from the posterior wing, but obscurely defined anteriorly. Beak near the anterior part of the hinge, acute, and curves forward over the cardinal line, beyond the beak of the other valve. Anterior wing small; posterior wing triangular, flat; extremity acute, and margin concave. Surface marked by crowded, wrinkled, concentric striæ that become closer and closer toward the margin of the shell. The right valve is about half as convex as the left, and the umbonal region is quite as clearly indicated. Surface smooth.

This species is quite variable in size, as shown by the illustrations, and even they do not represent either the largest or smallest specimens. The only difference observed in the growth of the shells is that the wings are proportionally slightly more developed with age. It would seem from the surface ornamentation of the shell to have its nearest affinity with *P. corrugata*, James, from the upper part of the Hudson River Group, though the ornamentation on that shell is more conspicuous, and the striæ less crowded than on this. It is distinguished, however, from *P. corrugata* by greater height in proportion to its length, greater convexity of the valves, smaller wings, and more extended beak of the left valve. This is a rare species, occurring in the middle part of the Hudson River Group, in the higher stone quarries, on the hills about Cincinnati. The specimens illustrated belong to the collections of the authors.

TECHNOPHORUS FABERI, S. A. Miller.

Plate 1, Fig. 20, left valve of a large specimen.

This species was described from complete casts, and from shells having the posterior wing-like extension broken away, and even the point of the postero-basal extension was slightly broken off. We are able now to figure a complete valve

showing the remarkable posterior lanceolate extension, which curves upward, so that the point is higher than the beak of the shell. Both sulci arise behind the beak and extend to the postero-basal part of the shell where the intervening ridge terminates in an acute point. The posterior sulcus is deep, and seems to bound the body of the animal, leaving a thin, lanceolate, upward-curving, wing-like extension behind it. The specimen illustrated was found at the same place that the original types were found, in the middle part of the Hudson River Group, at Sharonville, Hamilton County, Ohio, and is now in the collection of Mr. Charles L. Faber.

BELLEROPHON GLOBULARIS, n. sp

Plate 1, Fig. 21, dorsal view of a specimen not perfect at the aperture; Fig. 22, dorsal view showing the lateral, backward curve of the aperture.

Shell medium or rather below medium size; globular in form and closely coiled. Umbilicus closed. Aperture bilobed, wider than the antero-posterior diameter, lip laterally curved backward or trumpet-shaped, deeply sinuate or notched in front. The dorsum of the outer volution is broad, and bears two concave, shallow furrows, that increase in width toward the aperture, and are separated by a low, rounded band. Surface marked by concentric lines of growth, which, ascending from the umbilicus, curve forward on the sides and then more abruptly backward on the dorsum, so as to cross the central rounded band in a short and sharp curve, in line with the deep notch in the anterior margin of the aperture.

This species, in its globular form, bilobed aperture and surface markings, is very much like *B. bilobatus*, from which it is distinguished by the broad, shallow furrows on the dorsum and trumpet-shaped lateral lips. Found in the lower part of the Hudson River Group, at Cincinnati, Ohio, though good specimens are quite rare. The two specimens illustrated are from the collection of Mr. C. L. Faber.

BELLEROPHON CINCINNATIENSIS, n. sp.

Plate 1, Fig. 23, dorsal view of a specimen preserving some of the surface ornamentation of the shell; Fig. 24, ventral view of the same specimen.

Shell of medium size, subrhomboidal in outline, rather than globular, with the lip laterally expanded. Umbilicus closed, by a callus of the lip, on each side. The aperture is expanded, but, as our specimens are all defective at this place, the extent of the expansion can not be accurately ascertained; from the curving over of the callus of the lip, however, and other parts preserved, it is evidently as wide and probably wider than the antero-posterior diameter. The dorsum of the outer volution bears a sharp angular keel or band, which becomes more and more prominent toward the aperture. Surface of the shell ornamented with rather coarse, transverse lines, on each side of the keel, that curve forward from the keel and then backward toward the umbilical region, where they become obsolete. This ornamentation probably represents concentric lines of growth and indicates the depth of the notch at the anterior margin of the dorsum, as well as the expansion of the aperture.

This species is not so closely coiled as *B. bilobatus*, has a marked, curving callus to the lip, which that species does not possess, beside being distinguished by its keel and concentric or sigmoidal ornamentation or lines of growth. It occurs in the Hudson River Group, at the quarries in Cincinnati, but is rare and generally poorly preserved. The specimen illustrated is from the collection of Mr. C. L. Faber.

CYPRICARDITES HAINESI, S. A. Miller.

Ischyrodonta, Ulrich, is manifestly a synonym for Cypricardites, and *Ischyrodonta truncata*, the type of the genus, we think, may readily be shown to be a synonym for *Cypricardites hainesi*. Mr. Ulrich says, in his definition, that he had seen

specimens of his *Ischyrodonta truncata* labeled "*Cypricardites hainesi*, S. A. Miller, a shell occupying the same horizon." He was, therefore, aware that his genus and species is from the same horizon, and others had labeled it *Cypricardites hainesi*, before he described it; but, he says "there is little reason for confusing the two, since Miller's species has posterior cardinal teeth, is less convex, and not so high posteriorly." These are all the distinguishing differences he refers to, and as we know of none other, we will proceed to examine the value of these with the light we have before us.

First.—We have been unable, from Mr. Ulrich's figures or description, to discover that his species is any more convex than *Cypricardites hainesi*, and we have examined a great many shells and casts with this point specially before us.

Second.—We have been unable to discover that Mr. Ulrich's figures or description show his species is any higher posteriorly than *Cypricardites hainesi*; and, on these two points we are willing to submit the question to the judgment of competent paleontologists, upon offering, in evidence, the original figures of the two specimens of *Cypricardites hainesi*, reproduced in North American Geology and Paleontology, on page 476, and the illustrations of Mr. Ulrich, on page 174, of Vol. VI, of the American Geologist, with or without the types or other specimens. We are perfectly satisfied there is nothing in either of these two characters to distinguish the two species.

Third.—We now come to the question of the posterior cardinal teeth—a character of importance, if the differences claimed by Mr. Ulrich have any existence, as a matter of fact. We have not seen Mr. Ulrich's types, but as he drew his own illustrations, and we think they are correct, it ought not to be necessary to see the types in order to judge of the value of the generic or specific characters. Here we may remark that the casts of undoubted *Cypricardites hainesi* are just exactly like the casts of *Ischyrodonta truncata*, and this is what we would expect, if the two species were distinguished only by the presence or absence of posterior cardinal teeth. The casts of *Cypricardites hainesi* were found in the same cart-load of earth with the types that were figured twenty years ago, and the authors of this paper have collected them at

other places, and never had any doubt about identifying them, and, recently, have made comparisons with the original specimens, with the result of confirming former observations.

These remarks then, in our estimation, dispose of the three casts figured by Mr. Ulrich. The next point to which we would call attention is the fact that Mr. Ulrich's specimens are not by any means as well preserved as the types of *Cypricardites hainesi*. This is certainly evident from the illustrations, but we can add that the shell of the type of *Cypricardites hainesi* is the best preserved of any Lamellibranch shell we have ever seen from the rocks at Richmond, Indiana. We now come to the gist of the subject—the absence of the lateral teeth. On this point we may say, it is well known to all collectors, that they seldom find the teeth of Lamellibranchs in the Lower Silurian rocks well preserved, and in this particular species one of the authors has a hinge line, having the lateral teeth so poorly preserved that they can be distinguished only with difficulty, and we can very well understand from the appearance of the figure of Mr. Ulrich's specimen, that the hinge line is not in a good state of preservation, and that the lateral teeth have been destroyed. Indeed, the improbability that a shell should have such a wide, flat, lateral face and such strong cardinal teeth, and large posterior muscular scar is so great that we would require that some one should see a well-preserved hinge line before accepting that as the normal condition of the species. After a careful examination of all the specimens in several collections as well as our own, we are left without any doubt on this point. It is for the reasons thus stated that we class *Ischyrodonta* as a synonym for *Cypricardites* and *Ischyrodonta truncata* as a synonym for *Cypricardites hainesi*.

Ischyrodonta elongata is founded upon casts that may belong to an undescribed genus. We have a large number of the casts of this species, and some of them appear to be in a better state of preservation than Mr. Ulrich's types. We think the species may be recognized from the casts, while the genus remains in doubt. In its general outline it reminds one of *Sphenolium*, but the muscular scars at once separate it from that genus. The muscular scars and wide cardinal line are like *Cypricardites*, but the high angle of the cardinal line

and alation posterior to it are not the characters possessed by any of the described species in that genus.

At the present, we think we are not justified in proposing a new generic name for it, and prefer to wait until something is known of the cardinal teeth and hinge line.

LEPIDOCOLEUS JAMESI Faber.

One of the authors, Mr. Faber, desires to correct the definition of *Lepidocoleus* and of *Lepidocoleus jamesi*, as it appears in Vol. IX, p. 15, of this Journal, by saying that a transverse section, instead of being triangular, is somewhat heart-shaped, and the two series of plates are alike. On the dorsal side each row, or series of plates, is rounded at the overlapping apices of the plates, and between the rounded ridges thus formed there is a well-defined furrow or depression.

CYRTOCERINA MADISONENSIS S. A. Miller.

At the time one of the authors described, for the Eighteenth Indiana Report (Adv. sheets Eighteenth Rep. Geo. Sur. Ind., p. 64), a fossil under the name of *Tryblidium madisonense*, the internal part of it was not disclosed by the specimens at hand, while the external shell was remarkably well-preserved and looked like that of a Gastropod, and the form was that of a rather high Tryblidium. There was nothing in the shape or external appearance that would create the slightest suspicion that it belonged to the Cephalopoda. After that time specimens were collected showing a short, very rapidly tapering siphuncle, terminating on the concave side, below the apex and occupying the same position as the siphuncle in *Cyrtocerina*. Prof. Geo. C. Hubbard was the first to find that it was a chambered shell and possessed a siphuncle, and an examination of his specimens by the author led him to the conclusion that it is a true *Cyrtocerina*. The chambers are short, though longer than they are in *Cyrtocerina typica*, and the shell expands somewhat more rapidly than it does in that species.

Heretofore there have been only two species known in this genus. The oldest, *Cyrtocerina mercurius*, from the Taconic rocks, the most elongated species and having the shorter septa, and *Cyrtocerina typica*, from the Black River Group. The species here under consideration is from the extreme upper part of the Hudson River Group, which gives a range to this genus, commencing below the Silurian rocks and extending to the very top of the Lower Silurian system.

BIOLOGICAL NOTES ON REARED PARASITIC HYMENOPTERA OF OHIO AND INDIANA, WITH DESCRIPTIONS OF THIRTEEN NEW SPECIES, BY W. H. ASHMEAD.

BY F. M. WEBSTER, M. SC.

In this paper the author has included species of Hymenoptera reared by himself in Indiana and Ohio, exclusive of those described in Bulletin No. 3, Technical Series of the Ohio Agricultural Experiment Station, and in the Proceedings of the Indiana Academy of Science, 1892, excepting such as were yet undescribed at the time the latter publication was prepared.

These hymenoptera are largely parasitic, though it has not been possible in all cases to give the host. In the first mentioned publication, ten new species and one new genus are described by my friend, Mr. W. H. Ashmead, of Washington, D. C., and following this paper will be found descriptions of thirteen additional species by the same gentleman, as with the others, the types having been reared by myself. This material, together with considerable additional, not yet ready for description, was reared during the last ten years, during the first eight of which I was connected with the U. S. Department of Agriculture as special agent, and attached to the Indiana Agricultural Experiment Station, and later, to the Ohio Station, and still later, as the entomologist of the latter Station. The object has never been to collect material of this sort, but to rear it, and thus secure as much biological information as was possible. In a number of cases the host insect was not recognizable, and in others it is quite possible that the parasite may be secondary, though the attempt has been made to indicate such, where the fact was known. No attempt has been made toward any systematic arrangement of the species in the order in which they would fall in any

classified list of Hymenoptera, the object being to place on record, and within the reach of other workers, a basis upon and about which they may build, the species, as will be noticed, including not alone the new, but also many old ones, the locality being new.

ENCYRTUS BUCCULATRICES Howard. (Fig. 1, Plate II). Reared from cocoons of *Bucculatrix pomefoliella* Clem, at Wooster, Ohio. This species was described in Lintner's first report as State Entomologist of New York.

AMBLYASPIS MINUTUS Ashmead. This was reared at Lafayette, Indiana, from Oak twigs affected by the larvæ of some species of *Agrilus*, but as it is a Cecidomyiid parasite, the true host was not observed. Reared also at Wooster, Ohio, from wheat straws. Habitat, Washington, D. C., and St. Louis, Mo. Description in Bull. 45, U. S. Nat. Mus., p. 269.

TETRASTICHUS ENCYRTI Ashmead. The types of this species were reared with the preceding, it being probably a hyperparasite, and the host is unknown to me. For description, see Mr. Ashmead's paper.

HERPESTOMUS PLUTELLÆ Ashmead. Reared at Columbus, Ohio, from the larvæ of the Diamond-back Cabbage Moth, *Plutella cruciferarum* Zeller. The types of this species were reared by myself at Lafayette, Indiana. Described in Proc. U. S. Nat. Mus., Vol. XII, p. 196, 1889.

MESOLEPTUS FUNGICOLA Ashmead. Reared from a fungus, *Polyporus applanatus* Fr., in the vicinity of Wooster, Ohio. Larva collected in October, the adult emerging the following spring. Type specimens, the host unknown. For description, see Ashmead's paper.

DACNUSA CRASSITELA Provancher. Reared at Wooster, Ohio, from stalks of *Ambrosia trifida* L. In early Spring, in the pith of this plant, were found in considerable numbers pupæ of two species of Diptera, the first belonging to an undetermined species of *Agromyza*, and the other to *Diastata* n. sp., the latter being the host for this species. Habitat, Ottawa, Canada. Described in Add. Faun. Hym., p. 148.

SYNTOMOPUS AMERICANUS Ashmead. This was reared with the preceding, but probably from the pupæ of *Agromyza* sp. Adults appear in April and early May. Described in Mr. Ashmead's paper.

AULAX MULGIDIICOLA Ashmead. This species was reared from galls within the stems of *Lactuca canadensis* L., both at Lafayette, Indiana, and also at Columbus, Ohio. The species had been previously described by Mr. Ashmead, who finds it about Washington, D. C., breeding in *Mulgidium acuminatum*.

CHRYSOCHARIS COMPRESSICORNIS Ashmead. The types were reared from stalks of *Lactuca canadensis* L., within which were the galls of *Aulax flavicornis*, at Columbus, Ohio. Described in Mr. Ashmead's paper.

POLYSCELIS WEBSTERI Ashmead. The types were reared with *A. mulgidiicola*, at Lafayette, Indiana. This may be parasitic on the gall maker, or either *Eurytoma aulacis* Ashmead, or *Opius aulacis* Ashmead, as all four of these species were reared from the same stalks of *Lactuca*. It seems more probable, however, that the *Eurytoma* is the host for the *Opius* and the parasite of the *Aulax*. This opinion is strengthened somewhat by the fact that Mr. Wm. Brodie, of Toronto, Canada, reared *E. aulacis* and also *Dacnusa crissitela* Provancher, from galls of *Aulax nabali* Brodie, in the stems of *Nabalus altissimus* Hook. (Can. Ent. Vol. XXIV, p. 12, 1892.) This leaves the *Polyscelis* parasitic on either the *Eurytoma* or *Aulax*, with the probabilities in favor of the latter. For description of *Polyscelis*, see Mr. Ashmead's paper.

TETRASTICHOIDES LASIOPTERÆ Ashmead. The types of this species were reared from galls of *Lasioptera muhlenbergiæ* Marten, formed on *Muhlenbergia mexicana* Trin. For description, see beyond.

I may here state that there are two galls formed on *Muhlenbergia*, that of *Lasioptera muhlenbergiæ* Marten, being shown in Fig. 2, Plate II, while the second is formed by *Chlorops ingrata* Williston. The last is usually smaller, and not so symmetrically formed, and for a time I mistook them for

aborted galls of the Lasioptera. The galls from which types of all the species mentioned were reared, were sent me by Prof. McFadden, of Westerville, near Columbus, Ohio.

MENISCUS 4-CINCTUS Ashmead. Of this I can only state that the types were reared by myself from a chrysalis, found in the folds of a peach leaf, collected on Catawba Island, Ohio, on the shore of Lake Erie. For description see beyond.

CLINOCENTRUS TARSALIS Ashmead. The types of this species were reared under rather peculiar circumstances. For some time my botanical friends in Columbus have complained of the ravages of an herbarium pest, probably the larvæ of a species of Pyralid, which destroyed dried specimens of plants of the genus *Gentiana*. Although the depredator would not be observed at the time the plants were collected and pressed, soon after this the bloom would be attacked, and later on the foliage would be also destroyed, the larvæ finally eating holes in the papers and later transforming to the chrysalis without constructing a cocoon. While attempting to rear the adult moths from material sent me by my friend Prof. Selby, of the Columbus high school, this species emerged in the breeding jar where the *Gentiana* feeding larvæ were confined. Not being successful in rearing the moths, it is, of course, impossible to give the name of the host. For description, see Mr. Ashmead's paper.

PEZOMACHUS OBSCURUS Cresson. Reared at Columbus, Ohio, from eggs of spider; which eggs were enclosed in disc-shaped nests and fastened to the surface of stones. Previously described from New Jersey.

HEMITELES DRASSI Riley. Types reared with the preceding, at Columbus, Ohio. The female has not yet been observed, at least so far as published record goes, and while it might be too much to state in a positive manner, yet it is quite possible that this sex is confused with other species. The host is a Drassid spider. Described in *Proc. Ent. Soc. Wash.*, Vol. II, p. 296.

EURYTOMA STUDIOSA Say. Reared from Dipterous galls on *Erigeron canadense* L., at Lafayette, Indiana. Description

in Bost. Jour. Nat. Hist., Vol. I, p. 272. Complete writings, LeC. Ed., Vol. II, p. 721.

EURYTOMA DIASTROPHI Walsh. Reared from galls on *Ambrosia artemisiæfolia* L., caused by *Tripeta gibba* Loew. Mr. Walsh reared this from Cynipidous bramble-galls of *Diastrophus nebulosus* O. S., and variety *Bolteri* Riley, was reared from galls on Solidago made by *Gelechia gallæsolidaginis* Riley. The species is described in Am. Ent., Vol. II, p. 299. Habitat, Canada and Illinois. My specimens were from New Harmony and Lafayette, Ind.

CEROPTRES PISUM O. S. Reared from galls on Pin Oak, *Quercus palustris* Mx., at Wooster, Ohio. Osten Sacken described the species from specimens reared at Washington, D. C., from *Q. alba* L. and published description in Proc. Ent. Soc. Phila., Vol. I, p. 59.

TELENOMUS PODISI Ashmead. Reared from wheat stubble at LaPorte, Indiana. The habitat is given as St. Louis, Mo., and the host as the eggs of *Podisus spinosus* Dall. The host of my specimens is, of course, unknown. Described in Bull. 45, U. S. Nat. Mus., p. 158.

TRISSOLCUS THYANTÆ Ashmead. Described from specimens reared at Selma, Alabama, from the eggs of *Thyante custator* Fabr. My rearings were at Lafayette, Indiana, and from eggs probably of the above species, as they closely resembled those of *Podisus spinosus* Dallas, which is true of those of *T. custator*.

LABEO TYPHIOCYBÆ Ashmead. The types were reared by Prof. Riley, at Washington, D. C. The host was in this case a species of Jassidæ. Reared by me at Lafayette, Indiana, from wheat stubbles, Nov. 26, 1889. Described from the Washington specimens, Bull. 45, U. S. Nat. Mus., p. 90.

ACOLOIDES HOWARDI Ashmead. Habitat Washington, D. C. This is a parasite on eggs of spiders, and was reared by myself at Lafayette, Indiana, with the preceding species, from wheat stubble. The description will be found in Bull. 45, U. S. Nat. Mus., p. 171.

BRACON FUNGICOLA^{*} Ashmead. Types reared by myself from Black Knot, *Plowrightia morbosa* Schw., and collected in Wayne County, Ohio. For description see beyond.

PHÆNOCARPA FUNGICOLA Ashmead. Types reared with the preceding species. Described also by Mr. Ashmead in his paper.

GLYPTA VULGARIS Cresson. Reared with the preceding. Described in Trans. Am. Ent. Soc. Vol. III, p. 154, the habitat being there given as Eastern and Middle States, but now known to have a much wider range.

In regard to the respective hosts of the three species last mentioned, it is impossible to give exact information. The other inhabitants of the fungus, from which they emerged, were as follows: Two undetermined species of Diptera, a Cecidomyid and a Muscid; *Secia pictipes* G. & R.; *Euzophera semifuneralis* Walk; *Tortrix* sp? and *Hydnocera verticalis* Say. Besides, the larvæ of *Conotrachelus nenuphar* Hbst., has been known to inhabit this fungus, though in this case there was no evidence of their occurrence.

PYGOSTOLUS AMERICANUS Ashmead. The types were reared with the Labeo and Acoloides previously mentioned. This wheat stubble was badly infested with Hessian fly, yet the date of the emerging of this species, Nov. 26, renders it doubtful if this is the true host. Described in Mr. Ashmead's paper.

BRACON RHYSEMATI Ashmead. The types were reared at Wooster, Ohio from the larvæ of *Rhyssomatus lineaticollis* Say, working in the seed pods of *Asclepias incarnata* L. The same parasite was reared from the same host species at Lafayette, Indiana, and infesting the same species of *Asclepias*. See Proc. Ind. Acad. Sci., 1892, p. 89. Described in Mr. Ashmead's paper. Also, probably occurs in New England.

MERISUS SUBAPTERUS Riley. This was described in 1885, from types reared in Missouri, from the Hessian fly. My own specimens were reared from wheat stubble, also infested with Hessian fly, at LaPorte, Indiana. Described in Proc. U. S. Nat. Mus., 1885, p. 416, Pl. XXIII, Fig. 2.

POLYGNOTUS SALICICOLA Ashmead. The types of this species were reared at Los Angeles, California, by Mr. Kæbele, and from Cecidomyid galls on the midrib of willow. My single specimen was found alive in one of my insect boxes, which, on account of my absence from home, had not been opened for some weeks. It must have emerged in the box and from a minute Cecidomyid larva that had been introduced by accident. It certainly occurs in Wayne County, Ohio. Described in Bull. 45, U. S. Nat. Mus., p. 305.

CREMATUS RETINIÆ Cresson. Described in 1879, from New York. My specimens were reared from the larvæ of Crambus, probably, and among them *C. luteolellus* Clem., and were collected in Ashtabula County, Ohio. The species was described in Rep. Ent. U. S. Dept. Agric., 1879, p. 238.

HEXAPLASTA MELANOPUS Ashmead. The types of this species were reared from pupæ of a small, dusky Dipteron, *Leucopis* sp., the larvæ of which destroyed the cherry aphis, at Shreve, Wayne County, Ohio, in Summer of 1893. For description see Mr. Ashmead's paper.

EPHEDRUS INCOMPLETUS Provancher. Described in Add. Faun. Hym., p. 156, the habitat being given as Canada. Reared at Wooster, Ohio, from aphis, infesting potato plants and roses in greenhouses, in September.

MICROPLITIS MAMESTRÆ Weed. Reared from larva collected at Shreve, Wayne County, Ohio. The cocoon of this species is fastened beneath the host, parallel, between the posterior pair of abdominal prolegs and the anal prolegs. Host, the larvæ of *Mamestra picta* Harris. Described in Bull. Ill. St. Lab. Nat. Hist., Vol. III, p. 2.

COPIDOSOMA CELÆNÆ Howard. This species is described from Missouri, where its host was *Celæna renigera* Stephens. The date of appearance was May 16th. On September 12, 1890, at Lafayette, Indiana, I found the species in great abundance on flowers of Helianthus. On September 11, 1893, I also found the same species equally abundant on the flowers of Helianthus, in the vicinity of Wooster, Ohio. Described in Bull. U. S. Dept. Agr., Div. Ent., No. 5, p. 11.

SYMPIESIS NIGRIPES Ashmead. Habitat, Kansas. Reared by myself from mines of a Lepidopterous leaf miner, in leaves of Burr Oak, at North Bend, Ohio, August, 1893. Description in Bull. 3, Exp. Sta. Kan. Agl. Coll., June, 1888.

HIPPOCEPAALUS MULTILINEATUS Ashmead. Fig. 3, Plate II. The types of genus and species reared in Kansas, August 20, 1887, from the locust *Lithocolletis*, *L. ornatella* Cham. My specimens were reared with the preceding, and the host in this case was probably *Lithocolletis hamadryadella* Clem. Described and figured with the preceding.

(?) GANYCHORUS GELECHIE Ashmead. The types were reared at Kirkwood, Missouri, by Miss Murtfeldt, from *Gelechia prunifoliella* Cham, May 15th. My specimens were reared with the preceding, besides being found in the cocoons of *L. hamadryadella*. Description in Pro. U. S. Nat. Mus., 1888, p. 645.

Besides the above three species two additional ones were reared from these same infested Oak leaves, all emerging late in August, the additional species, an Eupelmus and a Lysiphlebus, as yet being undescribed.

LYGOCERUS (MEGASPILUS) NIGER Howard. Fig. 4, Plate II. The types were reared by me at Lafayette, Indiana, July, 1889, and I have since reared them from the same hosts, *Siphonophora avenæ* Fab., sent me by Mr. W. B. Hall, from northern Ohio. The description will be found in Insect Life, Vol. II, p. 247.

ALLOTRIA BRASSICÆ Ashmead. Reared at Wooster, Ohio, from *Aphis brassicæ* Linn. Also from the same host, on Scotch kale, at Lafayette, Indiana. Mr. Ashmead reared his specimens from same host in Florida. Description in Bull. 14, U. S. Dept. Agric., Div. Ent., p. 14, 1887.

LAMPRONOTA RUFIPES Cresson. Reared from larvæ of *Hadena fractilinea* and *H. misera* Grt., collected in Ashtabula County, Ohio. Mr. Cresson described the species from specimens from Canada. Description in Can. Ent., Vol. I, p. 36.

PERISEMUS PROLONGATUS Provancher. Reared at Lafayette, Indiana, August 28, 1888, from the larvæ of *Crambus caliginosellus* Clem. Originally described in Can. Nat., XII, p. 265.

HALTICHELLA XANTICLES Walk. Described in Ann. Soc. Ent. Fr. Ser. 2, I, p. 147, from Florida. Reared at Columbus, Ohio, from cocoons of *Solenobia walshella* Clem., found under loose bark of dead Beech tree.

DEROSTENUS LEUCOPUS Ashmead. Habitat, Kansas. Reared from leaf miner in Beech, near Wooster, Ohio. Described in Bull. 3, Exp. Sta. Kan. St. Agl. Coll., June, 1888.

GONIOZUS COLUMBIANUS Ashmead. Habitat, Washington, D. C. Captured in folds of leaf of Sycamore, probably made by a Pyralid larva. Wooster, Ohio, October 5, 1893. Described in Bull 45, U. S. Nat. Mus., p. 76.

LYSIPHLEBUS RAPÆ Curtis. This is a foreign species described in England, and figured in Curtis' British Entomology. Reared by myself at Lafayette, Indiana, from *Aphis brassicæ* Linn, infesting Scotch Kale, and also at Wooster, Ohio, from same host infesting Rape. A field of this plant on the Experiment Station Farm became infested with not only this Aphis, but also by the larvæ of the Diamond-back Cabbage Moth, and *Pieris rapæ*, Linn, with their Dipterous and Hymenopterous enemies. From leaves of these rape plants were reared, besides this and *Allotria brassicæ*, the following four species.

ISOCRATUS VULGARIS Walker. Reared at Wooster, Ohio, with the preceding from *Aphis brassicæ*. Described in Entomological Magazine, Vol. II, p. 151.

LIMNERIA TIBIATOR Cresson. Reared with the preceding. Described in Proc. Ent. Soc. Phila., III, p. 259, 1864. Habitat, Illinois and New Jersey.

LIMNERIA RIVALIS Cresson. Reared with the preceding. Habitat, Texas. Described in Trans. Am. Ent. Soc., Vol. IV, p. 173.

PACHYNEURON SIPHONOPHORÆ Ashmead. Reared with the preceding, the host being *Aphis brassicæ*. Also reared from *Myzus ribis* Linn, from northern Ohio.

PLATYGASTER ERROR Fitch. Reared at Oxford, Benton County, Indiana, and at Columbus, Ohio, from *Diplosis tritici* Kirby. Described from New York by Dr. Asa Fitch, Entomologist of the State Agricultural Society, in his sixth report, p. 76, Plate I, Fig 4, he being somewhat in doubt, however, in regard to its host.

AMICOPLUS CRAMBI Ashmead. Reared at Lafayette, Indiana, from *Crambus zeellus* Fernald. For description see Mr. Ashmead's paper.

ENCYRTUS FLAVUS Howard. Reared at Columbus, Ohio, from *Lecanium hesperidum* Linn., on roses in greenhouse. Previously unknown outside of California. Figs. 5 and 6, Plate II. Described in Rep. Com. Agric. U. S., 1880, p. 367.

POLYGNOTUS HIEMALIS Forbes. Reared by myself from Hessian fly, at LaPorte, Indiana, in 1889. Prof. Forbes reared it at Champaign, Illinois, in 1888, and Prof. Cook in Michigan, in 1890. Described in Psyche, Vol. V, p. 39, April, 1888.

HEMITELES UTILIS Norton. Captured females running about over Peach trees, near Marblehead, Ohio, May 13th. Described from Connecticut and Texas, in Trans. Am. Ent. Soc., Vol. II, p. 326. Reared in Connecticut, from the cocoons of *Lophyrus abietis* Harris.

ICHNEUMON UNIFASCIATORIUS Say. Reared from larva of *Acronycta oblinita* Say, from Catawba Island, Ohio. Described in Complete Writings, Lec. Ed., Vol. I, p. 48, pl. 22. Habitat, Canada, U. S.

HECABOLUS LYCTI Cresson. Reared from Oak timber infested by the larvæ of *Lyctus striatus* Say, received from Springfield, Ohio. Described in Am. Ent., Vol. III, p. 24, habitat not given, but host as above.

SYMPIESIS NIGRIFEMORA Ashmead. Reared at Columbus, Ohio, from mines of Lepidopterous leaf miner on Elm,

August 25th. Described from Kansas, where it was reared from leaf mines on Balsam, Oak, and from the Apple leaf miner, *Tischeria malifoliella* Clem. Description in Bull. 3, Exp. Sta. Kans. St. Agl. Col., June, 1888.

SEMIOTELLUS CHALCIDEPHAGUS Walsh. Habitat, Canađa. United States. Described in Am. Ent., Vol. II, p. 368. This and the two following species, together with *Websterellus tritici* Ashmead (Figs. 1 and 2, Plate III), were reared at Wooster, Ohio, in connection with *Isosoma hordei* Harris.

EUELMUS ALLYNII French. Reared from the preceding, and also at Lafayette, Indiana, where it was parasitic on *Isosoma tritici* Riley. Description in Can. Ent., Vol. XIV, p. 9.

MERISUS ISOSOMATIS Riley. Reared with the preceding, both at Wooster and at Lafayette. Described in Rep. Ent. Dept. Agric., 1882, p. 186. Habitat, Tennessee.

TETRASTICHUS PRODUCTUS Riley. Reared at Wooster, Ohio, from wheat stubble infested by *Cecidomyia destructor* Say. Described from Missouri, in Proc. U. S. Nat. Mus., Vol. VIII, p. 419, pl. 23, 1885. Whether this is a primary or a secondary parasite has not yet been determined.

PACHYNEURON MICANS Howard. (Fig. 3, Plate III). Reared at Wooster, Ohio, from aphid on grass, and also on wheat stubble, the types being reared at Lafayette and Goshen, Indiana, from *Siphonophora avenæ* Fab. Described in Insect Life, Vol. II, p. 246.

APHIDIUS OBSCURIPES Ashmead. Types reared at Lafayette, Indiana, but the host is unknown. Reared at Wooster, Ohio, from wheat straws, the host probably some species of Aphides. Described in Proc. U. S. Nat. Mus., 1888, p. 660, 1888.

ALLOTRIA TRITICI Fitch. (Fig. 4, Plate III). Reared in considerable numbers in Indiana, from *Siphonophora avenæ*. Described in Fitch's Sixth Report Insects of New York, p. 99, the habitat being given as New York and Canada.

PERILITUS AMERICANUS Riley. (Figs. 5 and 6, Plate III). This species has been reared by myself in various localities

in Ohio, covering the entire latitude of the State. It was also reared at Oxford, Indiana, in 1884. Described in *Insect Life*, Vol. I, p. 338, 1889.

DESCRIPTIONS OF THIRTEEN NEW PARASITIC
HYMENOPTERA, BRED BY PROF.
F. M. WEBSTER.

BY WILLIAM H. ASHMEAD.

In this paper I continue descriptions of the interesting new parasitic Hymenoptera, bred and discovered by Prof. F. M. Webster in his entomological work, carried on at the Ohio State Agricultural Experiment Station. Many of these are of especial interest, not only from the fact that they destroy some of the more destructive insect pests of the field and garden, but as representing genera now for the first time noticed to occur in our fauna.

FAMILY CYNIPIDÆ.

SUB-FAMILY EUCÆLINÆ.

HEXAPLASTA FÖRSTER.

(1) HEXAPLASTA MELANOPA, sp. n. Male—Length, .65 mm. Highly-polished black; knees and tarsi, reddish-brown; wings hyaline, pubescent, the venation light brown, the second abscissa of radius about one-third longer than the first. Antennæ, brown-black, 15-jointed, longer than the body; scape and pedicel united very little longer than the first joint of flagellum, but stouter; first flagellar joint the longest, a little narrowed toward base, about three and one-half times as long as wide at apex, the following joints sub-moniliform, about twice as long as thick. Scutellum striated at sides, the cup very small, elliptic, with a single fovea behind its middle.

Abdomen ovate, sub-compressed, a little longer than the thorax.

Hab.—Wooster, Ohio.

Described from a single specimen. The small size and color of the legs readily distinguish the species.

FAMILY BRACONIDÆ.

SUB-FAMILY BRACONINÆ.

BRACON FABR.

(2) *BRACON FUNGICOLA* sp. n. Female—Length, 3 mm; ovipositor a little longer than the abdomen. Head and thorax, black, highly polished; space between the lateral ocelli and eyes, anterior orbits, face, mouth parts, except apex of mandibles which are black, legs, except the last joint of all the tarsi, and the apical half of posterior tibiæ and their tarsi which are black or dark fuscous, and sides of the abdominal segments one, two, and three and the extreme apical segments, honey-yellow or reddish-yellow; abdomen above delicately shagreened; wings, subfuliginous; the stigma and nervures dark brown.

Antennæ, 30-jointed, a little longer than the body; head transverse; mesonotum with a slight triangular elevation, but the parapsidal furrows are not defined or impressed; scutellum semi-circular, sub-convex; metathorax rounded off posteriorly, smooth, polished; wings with the second abscissa of radius two and one-half times as long as the first, the second sub-marginal cell along its lower margin a little longer than the first, the recurrent nervure not interstitial with the first transverse cubital, but joining an angle in the first sub-marginal cell.

Hab.—Wayne County, Ohio.

Bred in April, by Prof. F. M. Webster, from black knot, *Plowrightia morbosa*. This species is probably parasitic on a Coleopteron *Hydnocera verticalis* Say, living in this fungus.

(3) *BRACON RHYSEMATI*, sp. n. Male—Length, 2.1 mm. Brownish-yellow; stemmaticum, eyes, antennæ, except two

basal joints, disks of the three imperfectly defined mesothoracic lobes, metanotum and spots on dorsum of first, second, third, fourth and fifth abdominal segments, brown or blackish; the abdomen, except the two terminal segments, is shagreened. Antennæ 28-jointed, scarcely as long as the body, with the flagellar joints nearly equal, from two to two and one-half times as long as thick; head transverse, the cheeks convex.

Hab.—Wooster, Ohio.

Bred by Prof. F. M. Webster from *Rhyssomatus lineaticollis* Say.

SUB-FAMILY RHOGADINÆ.

CLINOCENTRUS HALIDAY.

(4) *CLINOCENTRUS TARSALIS*, sp. n. Female—Length, 3 mm.; ovipositor not quite the length of abdomen. Brownish-yellow; eyes, stemmaticum, antennæ, except basal joint, all tarsi, the metanotum, except apex, and usually the dorsum of first abdominal segment, black.

Head and thorax smooth, shining, with the middle mesothoracic lobe posteriorly depressed and somewhat rugulose; metathorax rugose; wings hyaline, the nervures, except stigma and the second branch of radius, light brown, the stigma and second branch of radius, yellowish. Abdomen ovate, not longer than the head and thorax united, compressed at apex, dorsally for a little more than two-thirds its length, longitudinally striated, its apex smooth and shining; the first segment is not quite twice as long as its breadth at apex, but longer than the second; the third segment is about two-thirds the length of the second; ovipositor black, clothed with sparse whitish hairs.

Hab.—Central Ohio.

SUB-FAMILY BLACINÆ.

PYGOSTOLUS HALIDAY.

(5) *PYGOSTOLUS AMERICANUS*, sp. n. Male—Length 1 mm. Head and thorax black, polished; abdomen and legs brownish-yellow; basal two joints of antennæ and trophi, whitish;

flagellum black. Head subglobose, the eyes whitish; antennæ 12-jointed, longer than the body, very gradually thickened toward apex, the flagellar joints long, cylindrical, sparsely pubescent. Thorax subovoid, the mesonotum wider than long, the disk somewhat flat, without furrows; metanotum yellowish toward apex, the surface smooth, delicately but distinctly areolated; wings hyaline fringed, the stigma and nervures brown; the cubitus arises from the basal nervure at about two-thirds its length, the discoidal cell therefore petiolated; first abscissa of radius not quite as long as the first transverse cubital; marginal cell large, but open. Abdomen oval, the first and second segments longitudinally aciculated, the rest smooth, shining; segments one, two and three occupy most of the surface, the second being the largest, the others, after the third, exceedingly short, somewhat retracted.

Hab.—Lafayette, Indiana.

Bred by Prof. F. M. Webster, from wheat stubble infested by the Hessian fly.

In the paucity of antennal joints this species differs from all other described forms, and this difference, in connection with the peculiarities noticed in the abdomen, render it easy of recognition.

SUB-FAMILY MACROCENTRINÆ.

AMICOPLUS FÖRSTER.

(6) *AMICOPLUS CRAMBI*, sp. n. Male—Length, 3.2 mm. Brownish-yellow; head black; mandibles and palpi pale or yellowish-white; legs paler than body.

Head transverse, the frons, above insertion of antennæ, impressed; face subconvex with a deep fovea between antennæ; mandibles conically pointed, feebly bidentate at apex; antennæ very long and slender, much longer than the body, multiarticulate, about 38-jointed, pubescent.

Thorax very distinctly trilobed, the middle lobe not attaining to the base of the scutellum, the lateral lobes with a longitudinal impression; metathorax longer than wide at base, with delicate lateral carinæ separating the metapleura from

the metanotum; wings hyaline, the stigma and venation yellowish; the submedian cell a little longer than the median; recurrent nervure not interstitial, joining the apical angle of the first submarginal cell; second submarginal cell subquadrate, the first abscissa of radius very nearly as long as the second; legs long and slender, the tarsi of anterior legs longer than their tibiæ, the tarsi of middle and hind legs about of an equal length with their tibiæ, the tibial spurs of hind legs very long.

Abdomen almost linear, smooth, the spiracles of first segment prominent, first and second segments very long, the second the longer; all the following segments united not longer than the second.

Hab.—Indiana.

Bred by Prof. F. M. Webster, from *Crambus zeellus*.

SUB-FAMILY ALYSIINÆ.

PHÆNOCARPA FÖRSTER.

(7) PHÆNOCARPA FUNGICOLA, sp. n. Male—Length, 1.6 mm; black, polished; collar, pleura, and mesonotum more or less piceous or dark rufous; mandibles, two basal joints of antennæ, legs, and petiole of abdomen, yellow. Head much wider than the thorax, the cheeks full, the occiput concave, the face convex; antennæ 23-jointed, nearly twice the length of body; thorax with the parapsidal furrows only slightly indicated anteriorly, the mesonotum with a fovea just in front of the base of the scutellum and connected with the latter by a very delicate carina that separates the basal fovea of the scutellum into two divisions; metanotum as long as wide, with a median carina, the surface almost smooth, with only some feeble transverse striæ posteriorly; wings hyaline, fringed, the venation yellowish, stigma lanceolate, second sub-marginal cell one and one-half times as long as the first, almost pointed at apex, the second transverse cubital being so extremely short; second discoidal cell wanting.

Hab.—Wooster, Ohio.

Bred by Prof. F. M. Webster, from Dipterous insects living in black fungus. This insect is not a true *Phænocarpa*, but belongs to Förster's sub-genus *Spanista*.

FAMILY ICHNEUMONIDÆ.

SUB-FAMILY TRYPHONINÆ.

MASOLEPTUS GRAV.

(8) *MESOLEPTUS FUNGICOLA*, sp. n. Male—Length, 3 mm.; black, polished; head large, subquadrate, wider than thorax, the occiput concave; eyes very large, extending to base of the mandibles; clypeus and mandibles, except outer tooth, brownish-yellow, fimbriate. Antennæ filiform, 20-jointed, pubescent, the basal four joints pale or yellowish, the following brown-black. Thorax above convex, trilobed, the scutellum with a deep fovea across the base, mesopleura smooth, metanotum punctate and distinctly areolated. Legs, including coxæ, brownish-yellow, the hind coxæ with a dusky blotch at base. Wings hyaline, strongly iridescent, the stigma and nervures piceous or dark brown, the areolet oblique, subsessile. Abdomen longly petiolated, the petiole linear about four times as long as thick, shagreened, and with a longitudinal median furrow beyond the basal one-third, the spiracles situated a little before the middle; body of abdomen long-ovate, its first and second segments (two and three with petiole) margined with red at apex, they, as well as the basal portion of the third segment, longitudinally aciculated, the segments beyond smooth, polished.

Hab.—Wooster, Ohio.

Bred by Prof. F. M. Webster, from fungus, the host being unknown.

SUB-FAMILY PIMPLINÆ.

MENISCUS SCHIÖDTE.

(9) *MENISCUS 4-CINCTUS*, sp. n. Male—Length, 6 mm.; black, polished; face below antennæ pale rufous; two basal joints of antennæ, clypeus and mandibles pale brownish-yellow; palpi pro- and meso-sternum, anterior and middle legs, including coxæ, second joint of trochanters of hind legs and knees, an irregular spot on each side of mesoscutum an-

teriorly but not meeting, apex of scutellum and metascutellum, and a triangular spot on the posterior angles of the metathorax, white or yellowish-white; hind legs reddish-yellow; the first joint of trochanters, annulus on their femora at base and another before apex, their tibiæ, except the white annulus at base and the tibial spurs and tarsi, fuscous or brown; abdominal segments one, two, three, and four, with a narrow reddish-yellow band at apex, venter pale with lateral blotches on each segment.

Antennæ brown-black, 34-jointed, acuminate, a little shorter than the body. Mesonotum trilobed, the metathorax rounded behind, nearly smooth, but under a high power lens exhibiting fine, transverse aciculations; legs rather slender, the tarsi longer than tibiæ, the claws pectinated; wing hyaline, the venation pale, the areolet small, oblique; abdomen linear, longer than the head and thorax united, with the genital sheaths large and broad.

Hab.—Catawba Island, Ohio.

Bred by Prof. F. M. Webster, from an unknown leaf-roller.

This species comes nearest apparently to *M. superbus* Prov., but differs in the color of legs and abdomen.

FAMILY CHALCIDIDÆ.

SUB-FAMILY PTEROMALINÆ.

TRIBE SPHEGIGASTRINI.

SYNTOMOPUS WALKER.

(10) *SYNTOMOPUS AMERICANUS*, sp. n. Female—Length, 2.5 mm. Bronzy-green, the occiput, pleura and metathorax purplish; abdomen, black, with an æneous tinge; legs, except the knees, tibiæ and tarsi, æneous or metallic, tibiæ and tarsi, except a blotch on the hind tibiæ toward base, brownish-yellow or honey-yellow. Head and thorax closely punctate or squameous, head transverse, wider than the thorax; antennæ, 13-jointed, the scape, except at extreme base, and the pedicel, æneous; flagellum brown-black, subfiliform, the

first joint the longest, the others to the sixth subequal, all a little longer than thick, the sixth quadrate. Thorax above flattened, the pronotum transverse-quadrate, as in *Eurytoma*, the mesothoracic furrows distinct only anteriorly; scutellum rather large, with the axillæ large, triangular and approaching more nearly together than in any other genus in this tribe, in this respect more like some of the Encyrtids; metathorax, long, with a delicate central carina; wings hyaline, iridescent, the nervures brownish, the marginal and post-marginal veins about equal, the stigmal vein being scarcely two-thirds the length of the marginal and sub-clavate. Abdomen distinctly petiolated, clavate, the body, as viewed from above, somewhat triangular; the petiole is stout, finely rugose, and a little longer than the hind coxæ, the rest of the abdomen smooth, shining, the second segment very long, occupying most of its surface, with a deep sulcus at base.

Male—Length, 2.2 mm. Agrees with the female, except it is more decidedly metallic-green, with all the tibiæ banded with brown, the antennæ filiform with the joints less compact, while the body of the abdomen is ovate.

Hab.—Wooster, Ohio.

Bred by Prof. F. M. Webster, from Dipterous larvæ.

TRIBE PTEROMALINI.

POLYSCELIS THOMSON.

(II) *POLYSCELIS WEBSTERI*, sp. n. Female—Length, 2.5 mm. Head and thorax bronzed green, closely punctate; prosternum bluish; abdomen pointed-ovate, æneous; antennæ 13-jointed, the scape pale-yellowish, the pedicel and flagellum dark-brown; legs, except hind coxæ, yellowish.

Head transverse, fully three times as wide (or a little more) as thick antero-posteriorly; eyes ovate; clypeus aciculated; mandibles rufo-piceous, the right four-, the left three-dentate, the inner tooth blunt; antennæ 13-jointed, the flagellum sub-clavate, about twice as long as the scape, the first funicular joint, including the two ring-joints, a little longer than the pedicel, the following joints very slightly and gradually shortening,

but widening, the last funicular joint being transverse; club stout, fusiform, 3-jointed. Thorax with the parapsidal furrows indicated only anteriorly for two-thirds the length of the mesonotum, entirely wanting on the posterior one-third; metanotum produced at apex and covering the short petiole of abdomen, the nucha distinct, the spiracles ellipsoidal, the superior margin of the metapleura covered with whitish hairs; wings hyaline, pubescent, the venation pallid, the marginal vein about two-thirds the length of the submarginal, the post-marginal a little longer than the stigmal, the latter ending in a small stigma; legs as in *Pteromalus*.

Abdomen ovate, subsessile, shaped as in *P. puparum* Linn.; first body segment the longest, the second and third about equal, together not longer than the first, the fourth shorter than the fifth.

Male—Length, 2 mm. Agrees with the female in color, except the flagellum is beautifully banded with white and brown, each alternate joint being contracted; the abdomen is brownish-yellow, except toward apex above; while the legs, including all coxæ, are yellowish-white.

The legs are of a peculiar structure, closely resembling those found in the genus *Platymesopus* Westwood.

The anterior tibiæ are subclavate, while the middle tibiæ are clavate with the outer edge much dilated, forming toward apex a leaf-like expansion, which is fuscous.

Hab.—Lafayette, Indiana.

Described from several specimens in both sexes, bred by Prof. F. M. Webster, from galls of *Aulax* sp.

This is the first species of this genus to be described in our fauna, the others being found in Sweden. The male, with its banded white and brown antennæ, is truly a lovely little chalcid. Nothing is known of the habits of the two European species.

SUB-FAMILY ENTEDONINÆ.

CHRYSOCHARIS FÖRSTER.

(12) CHRYSOCHARIS COMPRESSICORNIS, sp. n. Female—Length 2 mm. Head and thorax squameous, blue with a green-

ish-metallic tinge in certain lights; metathorax, including the post-scutellum, æneous; legs, except coxæ, white; abdomen æneous-black; antennæ 8-jointed, black, the scape with a light yellowish stripe beneath; flagellum pilose, the joints compressed or flattened; the funicle 3-jointed, loosely joined, the first the longest, almost as long as the 3-jointed club, the other two joints subequal, the second being about three times as long as wide, the third only two and a half times as long as wide; club 3-jointed, the joints compacted, the sutures scarcely distinguishable. Thorax with the mesothoracic furrows not defined posteriorly, the surface where they should be being only slightly depressed; metathorax short with a delicate median carina, the spiracles round; wings hyaline, iridescent, the nervures pale; the marginal vein is very long, nearly twice the length of the subcostal vein; the stigmal short, oblique, while the post-marginal is well developed.

Abdomen ovate, petiolated, the petiole short but distinct, punctate, constricted at base; second segment the longest, occupying about one-third of the surface of abdomen proper, the following segments all very short.

Hab.—Columbus, Ohio.

Bred by Prof. F. M. Webster from a Cynipidous Gall, *Aulax* sp. on *Lactuca*.

SUB-FAMILY TETRASTICHINÆ.

TETRASTICHOIDES ASHMEAD.

(13) TETRASTICHOIDES LASIOPTERÆ, sp. n. Female—Length 1.8 mm., black, subopaque; antennæ, brown; scape, tegulæ, trochanters, apical third of all femora, and all tibiæ and tarsi, light brownish-yellow; mandibles piceous. Head transverse, antero-posteriorly very thin, the frons concave, the cheeks flat; antennæ 10-jointed with two ring-joints, clavate, extending to tegulæ, the first funicular joint slender, cylindrical, the two following broadened, subequal. Mesonotum without a longitudinal impressed median line; scutellum with four impressed lines; metathorax short, with a delicate median keel, forked at apex; wings hyaline, the venation pale yellowish.

Abdomen sessile, broadly ovate, not longer than the head and thorax united, but a little wider than the thorax, highly polished, impunctate.

Male—Length, 1.5 mm. Agrees with female in color, but is smaller and narrower, with the flagellum filiform, the joints contracted at apex, covered with very long black bristles, while the abdomen is elongated and much narrower than the thorax.

Hab.—Central Ohio.

Bred by Prof. F. M. Webster, from a Cecidomyiid Gall, *Lasioptera* sp., found on *Muhlenbergia mexicana*.

THE PETRIFIED FOREST OF ARIZONA.

BY S. A. MILLER.

There is an extensive tract of land in the eastern part of Arizona, south of the Union Pacific Railroad, called the "Petrified Forest," though it is not a forest of petrifications; and it has even been more erroneously called "Chalcedony Park," though it is not a *park* in any sense of the word. Those who visited the World's Fair saw polished specimens of the petrified wood in the exhibits of Arizona and South Dakota.

I spent several days on this tract of land, and will attempt to convey to those who have not had such an opportunity some impression of it. First, cast out of the mind the idea of a forest, for there is none there, then follow my imagination of what may have taken place to produce the fossil wood, and possibly I can make myself understood in describing the present appearances.

Suppose there had been a lake or bay in that area, bordered on one side with a sandy plain bearing pine trees, and on the other side with volcanoes, in some comparatively recent geological age. We know there were volcanoes, for we can see lava distributed over hills and valleys for hundreds of miles in extent. We know there was a lake or bay, for sand, and gravel, and boulders, that are made by the action of water in rolling broken stone, are found in great abundance. We know there were pine trees, for we find fragments of the fossil trees in many places. And we conclude the pine trees grew in a sandy plain, not only because such trees flourish best in a sandy soil, but because the fossil trees, where undisturbed by the modern denudation of the country, are encased in a sand-stone matrix.

Suppose, now, that, through volcanic or earthquake action, the pine trees were uprooted, prostrated, submerged beneath the water, and buried in the sand, until they were subjected

to the slow process of fossilization. The water must have contained silica instead of lime, in solution, for the trees are silicified. If the water was heated by reason of its proximity to the volcanoes, may be the fossilization was accelerated. The fossil wood is chalcedony, more or less translucent, and of all shades and colors. No two pieces are shaded alike, and none are banded as agates. The delicacy of the tints is remarkable, and the material is used as a gem and an ornament. It would be only fair, therefore, to suppose that heated water aided and accelerated the fossilization. The coloring matter was probably from iron and copper, as some of the colors are those of gems tinted with copper, but, generally, the coloring is presumed to have the tints of iron.

During the period of fossilization, the sand in which the trees were embedded was cemented so as to form a hard, compact sandstone. Subsequently, through volcanic or earthquake action, the sandstone was elevated, and the lake or bay was drained. The prostrate trees and parts of trees that had been thus transformed by fossilization, into chalcedony, were held in a matrix of less hardness and more flexibility than the chalcedony. After that time, the trees could not accommodate themselves to the tremulous motions of the earthquakes as freely as the sandstone could, and the result was that they were broken into short sections or shaken into pieces while embedded in the matrix.

Since that time denudation from the ordinary wear and tear of the elements has played an important part in sculpturing and draining the territory. Generally, the sandstone containing the broken trees, which is only a few feet in thickness, constitutes the summit of the outliers, or less than one-twentieth of the country, over which the fragments of the trees are distributed. The country is eroded, between the outliers, from twenty to sixty feet, while the tops of the outliers, if connected, would appear almost one continuous plain. Or, describing the appearance in another way, the surface of the country is rolling, except that it is interrupted here and there with more or less abrupt and irregularly defined outliers, that indicate about the level of the country before the denudation that has taken place in the present geological age. The chalcedony, being imperishable under the action of the

elements, and too heavy for the ordinary rains to carry away, has remained in the eroded areas and valleys, while the lighter materials have been transported.

Now, standing on one of the outliers and looking across or up one of these eroded valleys, we see, in one direction, scattered here and there, the broken fragments of this chalcidized wood glistening in the sunlight; in another direction, clusters of the short sections of the trees, coated with dark oxide of iron, that look like veritable logs, and in another direction where the oxidized sections have rolled together and are still more numerous, they look like the logs sometimes seen on imperfectly cleared fields. The trees may have been two, three, four or five feet in diameter, but it is very rare to find an unbroken piece four feet in length. I saw one log in place about one hundred and fifty feet in length, but it was so shattered that a good section could not be found in it three feet in length. Sections two feet or less in diameter are generally solid, while those three or four feet in diameter are usually defective, indicating the presence of decayed places in the tree, and some of the larger pieces seem even to represent a hollow tree. Possibly the trees may have been shaken and injured, and so perfect has the petrification been that the defects are preserved, as well as the internal structure of the trees themselves.

THE GRANITES OF CECIL COUNTY, IN NORTH-EASTERN MARYLAND.*

BY G. PERRY GRIMSLEY.

I.

FIELD RELATIONS OF THE ROCKS.

It is proposed, in the following paper, to present the results of a study of the granites of Cecil County, in Northern Maryland. As the area occupied by these rocks is of too great extent to be thoroughly investigated in the limited time at my disposal, a certain portion of it was chosen which should be representative of the whole region. The area thus selected is roughly triangular in shape, as may be seen from the accompanying geological map. It is bounded on the north by the broad gabbro belt which crosses the river from Harford County; its south-western boundary is the Susquehanna River, while the eastern limit is marked by a line drawn south from the town of Rising Sun, across the granite, to the Columbian gravels. No previous geological work has been published on the crystalline rocks of this district, and the accompanying map is the first one to represent, in detail, the geological features of the region. The general effect of the topography is that of a plateau of two hundred feet elevation, cut into deeply at the west by the Susquehanna River, and incised to nearly equal depth by the numerous smaller streams. Its surface is gently undulating, except along the river, where the deep channels give the plateau a rugged appearance. The river soon reaches base level, and the towns along its side are only a few feet above the sea.

The rocks of this region are holocrystalline, with a north-east strike, and a highly-inclined dip to the south-east. The

*This paper was accepted by the Johns Hopkins University as a thesis for the degree of Doctor of Philosophy; and the writer is indebted to Dr. G. H. Williams for kind advice and valuable suggestions during the course of its preparation.

structure of the Piedmont plateau, of which this area is a portion, has been described by Williams,* and the topography has been outlined by McGee.†

ROCK EXPOSURES.

The uneven surface of the region is very favorable for good rock exposures, which are seen in the quarries, along the streams, and where the various roads cut into the hills as they descend into the valleys. In the latter class of exposures, however, the granites are often so much weathered that the specimens are not typical. Better exposures are to be seen along the streams. The banks of the Susquehanna River, within the area studied, present three different types of exposure. North of Rowlandville, the main granite wall, which is less than one hundred feet in height, stands back from the river two hundred feet or more and slopes down to the stream, so that the country rock is concealed to a considerable extent by vegetation and rock decay. In the space between this cliff and the river are large gabbro blocks which have been washed down from the north, probably in Columbia time. Below Rowlandville, for a distance of two miles, the rock wall retreats so far and becomes so low that no good exposures are afforded. At a distance of one mile above Port Deposit, the rock wall becomes perpendicular and approaches close to the river. This is continuous to Perryville, a distance of six miles, with an average height of nearly one hundred feet. In the vicinity of Port Deposit the natural river wall has been artificially moved back, to secure additional space for the town and railroad, and this has rendered the exposures especially fine. One mile south of the town the granite wall is cut by a number of diorite dykes, which vary in width from a few inches to five hundred feet. The granite, at this point, stands nearly vertical, and is much squeezed and crushed, having developed in it large eyes or nodules of epidosite. Through weathering, these cliffs present, especially toward the top, a very irregular, jagged

*Bul. Geol. Soc. Amer., Vol. II, pp. 303-318, 1890.

†Amer. Jour. Sci. (3) Vol. XXXV, p. 121, 1888; Annual Report U. S. Geol. Survey, Vol. VII, p. 616, 1883.

appearance, which is made the more prominent by the presence of sharp, gable-like masses, which are due to the probable existence of joint planes oblique to the foliation. At this locality, a small ravine cuts through the cliff along the strike of the rocks, excavating a deep channel; the vertical walls along its sides, through gravity, bend over at their tops, and so creep into the valley, giving the appearance of dipping to the south at an angle of forty-five degrees. This phenomenon is seen in Plate V, in which the observer is looking toward the east.

The smaller streams also yield good exposures, especially near the river, because, as their sources are approached their velocity is less and the channels become obstructed by gravel and debris. The best exposures are found in the quarries and railroad cuttings. It is of interest that the largest granite quarries of Maryland are those just north of the town of Port Deposit, operated at the present time by McClenahan & Brother. Its economic value is seen in the fact that it has been used in various government works, as in the forts along the Chesapeake Bay and the Atlantic Coast, and in the foundation of the Treasury building at Washington.

The rock is of light color, with dark biotite arranged in more or less parallel lines. This foliation has a north-east direction at right angles to the river, while its dip is nearly vertical. In addition to this parallel structure, there is developed a system of joints which are of great aid to the quarrymen in their work (see Plate VI). The principal joints strike north-east, in the same direction as the foliation, but their inclination to the parallel lines varies greatly even in a short distance. A second set of vertical joints runs at right angles to the main series, while a third set, trending west of north, is inclined 60 degrees to the principal joints. A fourth set of joints is approximately horizontal, but in some cases these show a decided curvature. In a number of places there are minor joints developed, which run at varying angles to the main set, and cause the stone to break into small irregular blocks.

ROCK TYPES.

GRANITE.

The granite which occupies most of the area studied, presents considerable variety, both in structure and mineral composition. As a rule, it becomes more foliated and gneissoid toward the east and south, so that the Port Deposit rock has heretofore been generally regarded as a gneiss, although it can be traced by slow transitions into the nearly massive granite of Rowlandville. As we shall see beyond, this natural difference is in great measure due to dynamic agencies, which have developed secondary parallel structures in certain parts of the granite mass. In the railroad cutting at Rowlandville, the granite exposed is quite massive and of a dark color. It is readily seen with the unaided eye to be composed of a feldspar largely changed to epidote, small quartz grains, and a considerable proportion of biotite, to which it owes its relatively dark hue. As this granite is followed northward into the valley of Octoraro Creek it becomes still darker in color, through a still further decrease in the amount of feldspar. This mineral now appears in rounded grains; it is accompanied by about an equal amount of quartz, and the rock has a somewhat parallel or gneissic structure developed in it.

Still further northward, as the gabbro contact is approached, the granite develops more and more of the ferro-magnesian constituents, containing hornblende as well as biotite, along with an increased amount of magnetite, until, finally, very near the contact, it is sometimes difficult to decide in the field whether a given rock should be classified as a granite or a gabbro. Numerous boulders of a sheared and squeezed chloritic rock are also found near the contact. The occurrence of such apparent transitions from one rock type to the other at their contact is especially noteworthy and interesting. Near the gabbro contact there also occur numerous sharply-defined patches in the granite. These were also observed at certain other points within the granite area, and fuller reference will be made to them beyond.

As the Rowlandville granite is followed eastward it retains the normal appearance described above as far as the town of Liberty Grove, although it occasionally carries in addition some secondary calcite. Near this last place the rock becomes much lighter in color through a decrease in the amount of biotite and an increase in the amount of white feldspar of the plagioclase series. Between these two towns, along the valley of Basin Run, the dark patches form a very characteristic feature, but disappear completely in the vicinity of Liberty Grove. To the south of this village a dyke of Mesozoic diabase was traced for nearly a mile.

The dark patches referred to above occur in small amount in the Port Deposit quarries and are more abundant in certain granites near Frenchtown, and they merit a special description.

BASIC SEGREGATIONS.

Oval or irregularly-shaped patches of a darker color and more basic composition than the surrounding rock, have been observed in granite areas the world over. Within the district here under discussion they are sufficiently abundant to demand attention, since their origin may throw some light on the nature of the rocks which contain them. The usual type of these dark areas has a distinctly foliated appearance, and is composed mainly of biotite and small masses of white feldspar, but there is considerable variation in composition within short distances. Some are composed of a fine grained aggregate of biotite, quartz and feldspar, or, in other words, a fine granular granite, imbedded in a coarse-grained rock of similar mineralogical composition. Other dark patches occur, which are composed almost wholly of biotite. The line of division between the darker rock and that surrounding it is usually a sharp one. In a few cases the specimens showed a gradual change from a lighter border to a darker interior which was similar to the other dark patches, but its outer margin was not clearly defined on account of this gradation. These dark areas vary both in shape and in size, but the characteristic shape is oval.

To account for the origin of such dark patches in granite, two hypotheses have been suggested: first, that they are

inclusions of a foreign rock; and second, that they are segregations of the more basic constituents of the granite, formed before its solidification. The facts observed within the region studied seem, on the whole, to indicate that these patches are basic segregations in the granite. The only other rocks which are certainly known to occur near at hand, and which might have furnished material for inclusions, are the gabbro and staurolite schist. There is, however, nothing to suggest gabbro or staurolite schist fragments, either macroscopically or in thin sections. Their mineralogical composition is, in all cases studied, the same as that of the granite in which they occur, except that they are richer in ferromagnesian constituents.

To test the relative acidity of the dark patches and the granite in which they occur, determinations of silica and specific gravity were made for me by Messrs. Reid and Magruder in the chemical laboratory of the University. In the following table the result is given, together with determinations of similar material from other regions.*

	SILICA.		SPECIFIC GRAVITY.	
	Granite.	Segregation.	Granite.	Segregation.
Port Deposit,	73.7	62.2	2.69	2.83
Peterhead, Scotland,	73.7	64.39	2.69	2.73
Shap, England,	69.8	56.95	2.69	2.77
Barr, Andlau,	68.9	57.89	2.68	2.78
Gready, Cornwall,	68.9	57.89	2.68	2.78

Most observers of similar patches in other localities have, after careful study, reached the same conclusion with regard to their origin. References to such work are given by Phillips,† Hatch,‡ and Zirkel|| in their papers on dark patches in granite.

While the weight of evidence indicates that the dark patches which are sparsely disseminated through the Rowlandville and Port Deposit granites at the localities above

*Zirkel Lehrbuch der Petrographie, Vol. I, p. 789, 1893.

†Quart. Journ. Geol. Soc. (London), Vol. 36, p. i, 1880.

‡Quart. Journ. Geol. Soc. (London), Vol. 44, p. 548, 1888.

|| loc cit.

mentioned, are to be regarded as basic segregations rather than inclusions of foreign rocks, they must, by no means, be confused with the finely-developed and abundant inclusions of darker rock which occur in the granite along the gabbro contact. As one follows the granite from Rowlandville to Porter's Bridge, over the fine exposures along Octoraro Creek, a very typical eruptive contact is seen. After half of this distance has been traversed, large and irregularly-shaped fragments of a more basic rock begin to appear in the granite, although these by no means possess the petrographical character of gabbro. These fragments, which are often seen to be disrupted and traversed by the enclosing granite, become steadily more abundant toward Porter's Bridge, while the granite itself, as has already been stated, grows more basic. The inclusions come to make up more than half the volume of the rock, and, finally, at Porter's Bridge, the granite is seen only to form intrusions into the more basic mass. With our present knowledge, it is, perhaps, impossible to satisfactorily interpret these inclusions. They seem not to represent the gabbro, at least in its typical development, but seem to have some genetic relation to the granite itself. It is not improbable that they may represent more basic portions of the granitic magma which have become differentiated and were the first to solidify, and which were subsequently broken into, brecciated, and included by later and more acid portions of the granitic magma. These inclusions would thus correspond to the *schlieren* of Reyer,* brecciated and included by later intrusions (*Nachschiebe*), as he has described them in the Tyrol and in the Sierra Nevada. The relations here encountered also resemble those found by Brögger† between the laurvikite and ditroite on Lange Sund, in Southern Norway.

A contact of this kind indicates that there is no very great difference in age between the more acid and more basic rocks, but that they represent different phases in the solidification of the same mass. The whole eruptive contact, so well displayed along Octoraro Creek, forms, itself, a kind of transition from the granite to gabbro, and plainly indicates that the latter is the older of the two rocks.

*Theoretische Geologie, p. 545, 1888.

†Groth's Zeits für Krystallog, u. s. w., Vol. XVI, p. 106, 1890.

This explanation of the abundant inclusions in the granite, as it approaches the gabbro, brings them, on one hand, into a kind of relation with the basic segregations described above, while it allies them to definite foreign inclusions on the other. In so far as they are early secretions of one great magma they resemble the former, while their relation to the latter consists in the fact that they must have been sufficiently solidified at the time of their inclusion to act essentially like rigid masses.

DIORITE.

This type is not present in any great amount, but it is represented in several belts of hard, black rock, near Port Deposit, extending in a north-east direction, parallel to the foliation of the granite-gneiss. That the number of these more basic belts is really greater than is indicated by those found in place, is shown by the large number of diorite blocks scattered over the fields. In the northern part of the area only one band of this dark rock was noted, and this was located near Harrisville.

If these diorite belts are projections from the gabbro mass at the north, and from the "Stony Forest" region of Harford County at the south-west, which have been completely changed through metamorphism, then these altered dykes furnish evidence that the granite in these areas is older than the gabbro, and also older than the granite in the neighborhood of Rowlandville and Porter's Bridge.

STAUROLITIC MICA SCHIST.

One and one-half miles south of Liberty Grove an interesting belt of rock was observed, which was traced for a distance of two miles from the river in a north-east direction. This rock is of a gray color, weathering brown, and it is composed mainly of mica and quartz mingled with red, dodecahedral garnets, which are covered with green chlorite. This schist is squeezed and crumpled into minute plications. Its best exposures are seen in the narrow valley of Basin Run, where the boulders are filled with completely altered staurolite

crystals. Both the schist and the staurolite crystals are dotted over with red garnets. In the small depressions along the hillsides, good crystals, which reach an extreme length of two inches, can be collected in large numbers. Single crystals are the most abundant, though twins of the two kinds usual for staurolite occur.

Passing from this typical locality of Basin Run to the south-west, the staurolite decreases in amount, so that in three-quarters of a mile it disappears, but the crumpled schist is still filled with garnets. If followed in the opposite direction the schist itself disappears, but in an area outside of the map and three miles to the east, near a village known as Principio, a small outcrop of a similar staurolite schist was seen.

Throughout the area, between the staurolite mica schist described and the gabbro mass at the north, the granite is massive and exhibits but little of the gneissoid appearance, while exposures of dioritic dykes and blocks resulting from their decomposition are very few. In these points this area offers a marked contrast to that south of the schist, where the granite is distinctly foliated, and where dioritic belts occur in large number. On account of these differences, it is thought best, for purposes of description, to use this schist as a division line in the area. The region north of the staurolite zone will be considered in the next chapter as the *Rowlandville Area*, and that south will be described in the third chapter as the *Port Deposit Area*.

[TO BE CONTINUED.]

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NATURAL HISTORY NOTES FROM NORTH CAROLINA.

BY A. G. WETHERBY.

Number Three.

THE LAND SHELLS OF ROAN MOUNTAIN AND VICINITY, CONTINUED.

23. *Z. ligerus* Say. This species is represented here, but varieties of the local form graduate into the next in a way to puzzle the most careful student of these specimens. *Acerrus* has generally been regarded as a variety of *demissus*. It is a more solid shell than the typical *ligerus*, and has a more polished appearance, owing to its less pronounced sculpture. The species in question ranges here through great variation in size and elevation of spire. It seems clear to me that all the sections of the ZONITINÆ, to wit, *Gastrodonta Omphalina* and *Vitrea* must suffer a marked reduction in species if we care for accuracy of determination.

24. *Z. acerrus* Lewis. Enough has been said about this form in the notes on *demissus* and *ligerus*. I collected elegant types of this form at Walker's Ford of Clinch River, in Union County, Tenn., in 1877, and have found it at other localities in both Tennessee and North Carolina many times since.

25. *Z. subplanus* Binney. In my Notes on American Land Shells, No. 2, this journal, December, 1881, I mentioned the

occurrence of this species at localities on Iron Mountain and the Roan, in this county. It has the peculiar habit of affecting the granitic and quartzite ridges, where it is found under leaves of the *Rhodendron* and *Kalmia* with which they are overgrown. I am forced, however, to abandon the suggestion made in that article, that this species and *inornatus* Say may be the same. The embryonic shells of this species are very densely wrinkled until they have attained a growth of three or three and one-half whorls. The under aspect of the two species is much alike—almost identical. If there is any difference, *subplanus* is the more highly polished. This is one of the most interesting species of *Zonites*, for several reasons. If we are to have these hair-splitting definitions, this species and *inornatus* must be removed from *Omphalina*.

26. *Zonites rugeli* W. G. Binney. This, the finest North American *Zonites*, was stated by me in the article quoted above to extend up the Roan to 5,500 feet. We have since found it on the very summit, at an altitude of 6,400 feet, there associated with *Mesodons wheatleyi* and *andrewsi*. I found this shell in 1877, during a trip made through the gorge of the Ocoee, but referred it, unwittingly, to the globular form of *inornatus* figured by Mr. W. G. Binney.

In the article referred to I mentioned "a variety of this shell, or possibly a distinct species, which differs in the following particulars: It is less polished; the color is a dark, smoky green; the sutures are less impressed, so that the whorls have a peculiar, overlapping appearance; the spire slopes away, as if the whorls had been cut down, removing their outer convexity, and giving the shell a peculiar profile." I will now add that I have found two or three specimens additional of this form. But they are so rare, and so far apart, that I fear they may be extreme varieties of this species. One young shell, however, shows the embryonic whorls to be *very different*. I call the attention of students and collectors to this form, which seems to be a very distinct one, and, probably, "a new species!" *Rugeli* has the habit of living in the leaves among the boulders and *débris* of cliffs, in damp places, and varies greatly in size. Our largest specimens have a major diameter of 39 mm. In passing from these larger species of *Zonites*, I again wish to ask the assistance of col-

lectors who have good, clean, perfect specimens, either for sale or exchange, as I am endeavoring to make a special study of them.

27. *Z. sculptilis* Bld. In the paper above quoted I cited this species as occurring sparingly here. The shells so called have since been described by Cockerell as *Z. carolinensis*. They average smaller than typical *sculptilis*, are thinner and lighter shells, have the spire more depressed and the radiating lines much more numerous or near together. If these close varieties are to be distinguished by specific appellations, this is as much entitled to recognition as *capnodes*, *acerrus*, *brittsi*, *sargentiana*, etc. This species, and its allies, *indentata*, *carolinensis*, and *subrupicola*(?), are very closely allied, and ought to be placed in a group by themselves. Mr. Pilsbry has so placed them, in marginal notes sent me, under the genus VITREA, with their anatomical alliances next to *Omphalina*. In this connection, it may be said that shells referred by such eminent authorities as Dall, Binney, and Dr. Pilsbry to *indentatus*, seem to me to be as far removed from that species as is *indentatus* from *sculptilis* or *carolinensis*, and as the habits and station of this form are so different from any variety of *indentatus* that twenty-five years of active study and collecting has brought me, I wish particularly to call attention to it. The shell is the most truly hyaline of all our species. It is a very delicate shell, being, in this respect, as diaphanous as *V. limpida*. The umbilicus is wide and well-rounded out. I call attention to this variety, as to all others in this article that have not been named, *in the interest of scientific consistency*. Why mere varieties shall be elevated to specific rank in one case, and simply passed over in others more distinctly marked is something for our book-makers to explain. This species or variety deserves careful study. The typical *sculptilis*, as described, occurs in the forests on the sub-carboniferous limestones of Tennessee, in magnificent development. It is a much heavier shell than *carolinensis*, and exhibits the other differences cited above.

28. *Z. carolinensis* Cockerell. This new species has been sufficiently discussed in the preceding note. It occurs in fair numbers, in scattered localities, in rotting leaves. The animals show no specific differences when compared with the above

or the following, so far as the most carefully-made dissections of freshly-collected material will show.

29. *Z. indentatus* Say *typus*. This species occurs here somewhat sparingly, under rocks, and occasionally in damp places, under bits of bark and wood. It exhibits no marked variation from types of the species as found elsewhere.

30. *Z. indentatus*? *umbilicate* var. It only remains to add to what was said under *Z. sculptilis* that this form occurs in the moss on boulders, and in leaves, and is very rare.

31. *Z. Elliotti* Redf. This species occurs here, always in rotting logs, or in rotten wood. The structure of the shell, the texture and color and the lingual dentition would rather ally this species with *Selenites*. The presence of a dart sac is no reason for putting it with *Zonites*. I believe it should be removed from the *Zonitinae* altogether, and I think it will be. It is, at least, a transition form. This shell is destroyed by a parasitic larva, the imago of which is a small and active species of *Diptera*. The grown larva occupies the shell as a pupa house after devouring the inmate. I have noticed this habit of the *Diptera* in the case of but one other species, and that is *P. fastigans* Say. At the only locality where I have collected this latter species, more than half the snails were affected, and the numbers of dead shells holding the empty pupa cases, were sufficient testimony to the activity of the parasite.

In writing up the characters which the shell of this species presents, I call attention to its wrinkled surface, to its dense and horny texture, and especially to the form of the last whorl and of the aperture, and to the marginal thickening of the peristome. These characters should have more weight in classification than a dart sac, which may occur in *Selenites* as well as *Zonites*, or the presence of true laterals, not always present in *Zonites*. This shell, in fact, is one of those forms that the systematists should make most of, *for their own safety!*

32. *Z. arboreus* Say. This species occurs here, as elsewhere, under bark of rotting logs, and exhibits no special characters worthy of note.

33. *Z. radiatulus* Alder. This shell is found here in damp woods, among the leaves, somewhat sparingly, many of the

specimens being of a beautiful wine color, while others are dusky and smoky. There is no special variation from the typical form worthy of note outside of the color.

34. *Z. minusculus* Binney. I have found this shell upon one occasion only. The station was in moss, on a large granite boulder, where it was associated with *ferreus* Morse, *Pupa contracta* Say, *P. simplex* Gould, *Vertigo pentodon* Say, and *H. lineatus* Say. The specimens were in all respects typical.

35. *Z. milium* Morse. This species was found associated as stated in the last note. It is rare here, and exhibits no character not typical.

36. *Z. ferreus* Morse. This species was found associated with the last two as stated. The shells were in all respects typical.

37. *Z. placentulus* Shutt. Typical specimens of this species occur here. I have collected this shell in Tennessee, Virginia, Kentucky, and here. It presents little variation except in point of size. It seems to be a comparatively rare species, and needs to be studied together with *capsellus*, *andrewsi* and *significans*.

38. *Zonites sterkii* Dall. A few specimens of this very rare species have been found here, among leaves, in the drier portions of the forest, associated with *pygmeum*, *fulvus*, *lineata*, and *Pupa pellucida* (?).

39. *Z. fulvus* Drap. This wide-ranging species is found in the forest, among the leaves, but always very sparingly. It represents no special characters different from the type.

40. *Z. gularis* Say. The most common land shell here, occurring everywhere in the forest, at all elevations, with the greatest possible variation in form and size, umbilicate and non-umbilicate. It is the most carnivorous and predaceous of all species, attacking and devouring animals much larger than itself. Some of the varieties would pass for typical *suppressus*. Some of the more widely umbilicate forms have alliances with *macilentus* and *lasmodon*, while the non-umbilicates range close to *cuspidatus* if they do not include it. This group of forms, beginning with *suppressus*, needs thorough revision by some one having an abundance of properly preserved material, of all ages, from authentic localities. When

this is done as it ought to be done, we may know something about the extent of specific variation possible in our land shells, hardly so well understood now as it ought to be. I am ready to contribute hundreds of specimens to the expert who will undertake the labor.

41. *Z. cuspidatus* Lewis. Typical examples of this form are found here. They are not so common, however, as most of the other varieties of the *gularis* group. The best types of the species (?) that I have seen were collected by myself and son fifty miles south of here in McDowell County, this State. Strange to say, no other forms of the group above mentioned occurred. Taken by themselves they might well be considered as a distinct species. But when hundreds of shells of intermediate forms are brought together, as we have them, the student can not say where a species begins or where it ends. The *Goniobases* of the Coosa River present no more intricate problem. It is safest to write all there is of this form under *gularis* and its varieties.

42. *Z. andrewsi* W. G. Binn. This beautiful shell occurs here in the leaves of the damper portion of the forest, together with *radiatulus*, *gularis*, *fulvus et al.* Some of the smaller specimens seem to have affinities with *significans*; others with *multidentatus* which occurs here with it. A good deal has been written about the "absorption of the denticles" in aged specimens of this and allied species, most of which is ill-advised and not in accordance with facts.

The exterior sculpture of *andrewsi* is much like that of *placentulus*, but no student of the two species need confound them. They are sufficiently distinct if the true *placentulus* is under consideration. In Pruitt's Gap of the Roan we found a rose-tinted variety of this species, of more than the usual size, which was, I believe, the most exquisite small land shell that I have ever seen. There is the same need of a thorough comparative study of *andrewsi*, *significans* and *multidentatus* that there is of *gularis* and its allies. With them should be considered *placentulus* and *capsellus*, which some writers have seemed to find it difficult to separate from these. This study can only be made by an expert who has hundreds of examples from the entire range of the species.

43. *Z. internus* Say. Found in rotting logs, and under them; has the habit of *Patula perspectiva*, with which it is nearly always associated. This species is out of place as usually arranged by the systematists, who have placed it with *Zonites* under *Gastrodonta*. The shell is not that of *Zonites* or any section of the genus. It is of the patuloid type, and, in fact, is, as well as the animal, a transition form. Nothing, it seems to me, could be more suggestive to the thoroughly earnest student of our shells than this species. Its habits, its shell and its anatomy will well repay the systematist for any time expended on them.

44. *Z. multidentatus* Binn. Typical specimens occur in the leaves, with the other species having the same habit, but somewhat sparingly.

44. *Philomycus carolinensis* Bosc. This slug is abundant in fields about stumps and old logs, and frequently ascends trees to a height of fifty or sixty feet, especially in wet weather. The markings run to an excess of variation that would set the variety mongers crazy. The general ground color also varies from very dark gray in some specimens to very light gray or cream color in others.

45. *P. Wetherbyi* W. G. B. This very distinct form has nearly the same habit as the above, but lives in leaves in damp places during Winter and hot dry weather in Summer. During rainy seasons it ascends trees to a great height, being sometimes found on the upper branches.

46. *P. hemphilli* W. G. B. This species also occurs here, but not so abundantly as the others. It is a darker colored and less marked species than its associates. It is also more slender. It is a very distinct form, and the wonder is how it so long escaped notice.

47. *Patula alternata* Say. This species is represented here only by the *var. fergusonii* Bld, very beautiful shells, and in every way typical. The type form and the variety *mordax* are not found here. The snail in question has the tree-climbing habit, and it may often be found in the moss on trees from ten to fifty feet from the ground.

48. *P. perspectiva* Say. Occurs in rotting logs, at the roots of dead trees, and always about decaying timber. The form is typical and exhibits little variation. I have collected, in

Union County, Tenn., a very sharply carinate variety with a depressed spire.

49. *P. bryanti* Harper. Station same as the last, also in rotting leaves with brush. Since writing my notes No. 2, in 1881, I have had opportunities to study this species carefully. No doubt remains that it is as distinct from *perspectiva* as any forms in the same genus could well be.

50. *Helicodiscus lineatus* Say. Found in leaves and occasionally under rotting logs, bark, etc. The species is rare here. It has close relationships with *Patula*, but is an aberrant form which needs thorough study in connection with the recognized divisions of *Pyramidula*.

51. *Punctum minutissimum* Lea. Found, not rarely, in leaves, together with many of the small species herein cited, but not "on rotten or decaying wood in forests" so far as our experience goes. The jaw of this species and other *Polyplacognatha* is composed of numerous plates, either not "soldered together" as in the present instance, or united by membrane, or more or less over-lapping, and in various degree of evolution toward the solid jaw or of retrocession from it. In many species these plates are curiously differentiated, some being bristle-bearing, others striate or minutely tuberculate. It has been held by recent writers that these characters are primitive, and indicate the antiquity of this group. I believe it has been suggested that it may even be a palæozoic remnant.

It may not be out of place to say in reply to this suggestion, that the highly differentiated shells of the *Polyplacognatha*, and their equally highly unique jaw, do not seem to me to indicate this vast antiquity, but rather that they are a group of high degree, whether of great age or not. Had the shells the size of the larger types of modern origin, they would be the most striking objects that could be obtained among the land mollusks. In support of this statement, attention is called to the species of *Laoma*, *Flammulina*, etc. The isolated geographical position of these latter groups is not suggestive of high antiquity.

52. *Carychium exiguum* Say. This shell occurs in great numbers, in damp leaves, together with the other small species herein enumerated. The variety found here is ex-

ceedingly delicate, hyaline, pearly white, and very slender. I sent this shell to Dr. Dall in 1887, with the suggestion that it might be a different species, but he responded with some specimens, effectually disposing of even the variety *exile*. If one of these forms is to carry a name, there are several as well entitled to do so. By far the more scientific method is to write all there is of *Carychium* under *exiguum*.

53. *Ferussacia subcylindrica* Linn. Of general occurrence here, in same station as last *et al*, but nowhere abundantly. The shells are larger than those of the same species found about Cincinnati. In Winter, and in dry hot weather of Summer, the aperture is closed by a white opaque epiphragm.

54. *Helicina occulta* Say. I have found this species somewhat rarely. The shells are more carinate than the typical *occulta*, and are of all shades of color, varying from bright yellow to greenish, through shades of light buff to white, and through darker shades to brown and red.

The station was on damp rocks and about them, under a slight covering of leaves. With them occurred a variety of the following species, the two being mixed indiscriminately.

I have hundreds of specimens of this *Helicina* from other localities, all of a dull red or brick color. Not a single specimen exhibits any approach to the fine tints found here. I shall be glad to correspond with any collector having well-marked varieties of this shell to exchange, as my experience has been, previous to finding this colony, that this species exhibits a maximum uniformity.

THE GRANITES OF CECIL COUNTY, IN NORTH-EASTERN MARYLAND.

BY G. PERRY GRIMSLEY.

II.

MICROSCOPICAL DESCRIPTION OF THE GRANITES OF THE ROWLANDVILLE AREA.

When the microscope is applied to the study of the granites whose macroscopic characters have been outlined, much additional light is thrown on their origin and history. While these rocks have not been so much altered as to wholly destroy their original features, they nevertheless display in an instructive manner the effects of dynamic action which has changed both their constituents and structures. Old minerals have been more or less metamorphosed, new ones have been developed, and a secondary foliated structure has been produced.

In the Rowlandville region these effects are less intense than in the vicinity of Port Deposit. While some crushing and secondary foliation has here resulted, the alteration is more mineralogical than structural. In the present chapter, therefore, we have, after reconstructing from what now remains the original rock type, to trace out more especially the development of new minerals, while in the succeeding chapter, on the Port Deposit granite, structural changes will become more prominent.

The most conspicuous metamorphic change in the Rowlandville rocks is the very extensive development of *epidote*. Physical conditions seem to have been most favorable to the production of this compound. It appears everywhere as a new metamorphic product, and exhibits a variety of appearances. It forms well-defined crystals, rounded grains and hair-like needles in all the original constituents alike. As a principal result of metamorphism in the Rowlandville area, this mineral will demand a good share of our attention in the present chapter.

The development of secondary muscovite is less important in this region, where the strain and crushing effects are slight, compared with those in the Port Deposit granites.

RECONSTRUCTION OF THE ROWLANDVILLE GRANITE TYPE.

We can readily reconstruct the Rowlandville granite type as it was before it suffered any metamorphism. It was a normal granitite or biotite granite of usual hypidiomorphic structure, and containing a large proportion of plagioclase of the albite-oligoclase series. In places it may have contained some original muscovite. It presented few structural variations, but showed a much more basic facies toward the adjoining gabbro.

ORIGINAL ESSENTIAL COMPONENTS.

The original essential constituents of the Rowlandville granites are feldspar, biotite, muscovite and quartz. Though orthoclase is found in small amount, the prevailing *feldspar* belongs to the more acid portion of the plagioclase series, albite and oligoclase, as determined by extinction angles and specific gravity. These feldspars are usually free from inclusions, and often possess a well-marked zonal structure, though in many cases this is partially or completely obliterated by metamorphic changes. They twin usually according to the Carlsbad law, though Baveno and Roc Tourné types also occur.

The *biotite* is less in amount than the feldspar, and is strongly pleochroic, with dark brown color in the direction of the cleavage, and light yellow at right angles to these lines. It occurs in basal and prismatic sections, but seldom in very large plates, since it is more or less broken. Its optical angle is small, the dark cross opening slightly, and its extinction is nearly parallel. It contains numerous inclusions of zircon, with pleochroic halos, sphene and epidote. A very characteristic feature in many sections is the presence of numerous needles crossing each other at 60° angles, which will be more fully described in another place. While *muscovite* is abundant

as a secondary mineral, resulting from the alteration of feldspar and bleaching of biotite, it also occurs, in a few cases at least, as a primary constituent, for it is bordered, intergrown, and even completely enclosed in fresh, strongly pleochroic biotite, and it has bent and broken cleavage lamellæ. This mineral contains inclusions similar to those found in the biotite, such as epidote and the small needles.



FIG. 1.—Quartz Mosaic, with hair-like inclusions, from Rowlandville granite.
x 80.

Quartz, in the form of a more or less coarse mosaic, occurs in large amounts in the Rowlandville granite. In a number of cases a considerable quartz area was seen to have once belonged to a single individual, from the regular grouping of certain abundant hair-like inclusions toward the center. Between crossed nichols such an area is now seen to be a mosaic of interlocking grains, as is diagrammatically shown in Fig. 1. Each hair-

like inclusion is broken at the junction of two quartz grains, and we may infer from this, that the quartz has been crushed subsequent to its original solidification.

ORIGINAL ACCESSORY COMPONENTS.

All of these Rowlandville granites possess a varied original mineralogical composition through a large number of accessory constituents. The most abundant of these is *allanite*, which is found in nearly every granite specimen, varying in size from minute grains to crystals 2 mm. in length, with zonal structure and strongly pleochroic. Since, however, this mineral is better developed in the Port Deposit granite, its physical and optical properties will be more fully described in the next chapter.

Zircon is a widely-distributed constituent, and occurs in most of the sections as small, stout prisms, doubly terminated.

These crystals will be more fully described in the section on bateâ separation.

Sphene occurs in irregular masses without crystal form, and also in the form of inclusions in the biotite. Its distribution is limited, and it was only observed in a few granites near Rowlandville and near the gabbro contact.

Tourmaline and *apatite* are not abundant, the former is rarely present, while the latter occurs as long, slender, broken crystals in the diorites and hornblende granites, and in shorter crystals in the other granites.

BASIC FACIES.

As the gabbro contact is approached there is a marked increase in the basicity of the granite, which becomes darker, and in some places it is difficult to separate from the gabbro in the field. This is caused by the presence of hornblende and magnetite, which were absent in the granites farther south.

The *hornblende* occurs in green, strongly pleochroic crystals of considerable size, with extinction angles varying from nearly zero to twenty degrees, according to the direction of its sections. It is filled with inclusions of magnetite, epidote and zircon. This latter mineral is interesting, since zircon is a mineral characteristic of the acid rocks, while it here occurs in a basic mineral and in a basic facies of the granite.

Magnetite, as proven by the magnet, becomes very abundant near the gabbro line. It occurs in irregular masses, and only rarely shows good crystal boundaries. It forms inclusions in the different rock constituents, such as quartz, feldspar, mica or hornblende, and often borders epidote, feldspar, biotite and zircon. It is sometimes scattered evenly through the rock in the form of small, more or less rounded grains, which are very abundant.

SECONDARY ALTERATIONS IN THE ROWLANDVILLE GRANITE.

EPIDOTIZATION.

Orographic movements and chemical changes have made important additions to the minerals which composed the

Rowlandville granite in its original condition. By far the most important of these new minerals is *epidote*, which has been formed on a very extensive scale. While this mineral occurs in nearly all the constituents, it is most abundant and most typical in the feldspar.

Since the epidote is abundant in feldspar crystals, which otherwise show no change, and in fresh granites where there has been no mineral decomposition by atmospheric agencies, its origin must be regarded as metamorphic rather than as due to weathering, although this has been frequently asserted to be the case.* The replacement of feldspar by epidote in the Rowlandville granites varies from nearly complete pseudomorphism to cases where only a slight amount of the new mineral is developed. In crystals of the latter sort the progress of change may be traced. It is then seen that the small epidote particles are equally disturbed through the feldspar, indicating that the alteration originates with equal readiness at any point. Where there is the least epidote it forms small crystals with sharp boundaries, and the characteristic monoclinic habit. As the alteration progresses, these small crystals unite into larger masses, which are easily seen under the low powers of the microscope to be a collection of separate grains of pale yellow color, often pleochroic. This change may, in certain cases, go so far as to conceal the original feldspar crystal, thus forming an incomplete epidote pseudomorph after feldspar. It is incomplete, because the outer border of the feldspar is always free from epidote. There is no especial tendency of the epidote to develop in or near cracks in the feldspar, nor does its arrangement bear any relation to the cleavage lines or twinning striæ of the latter. Thus, the host apparently exerts no orienting influence on the epidote, as is often stated to be the case. Moreover, in feldspar crystals which show pressure effects, such as undulatory extinction, a development of microcline structure, or a peripheral granulation of the crystal, little or no epidote is formed. This accords with the law of reciprocal relation between the amount of chemical alteration and the amount of crushing stated by Williams† in his work on the Michigan green stones.

*Vide Literature references in another place.

†Bul. U. S. Geol. Survey 62, p. 88, 1890.

The epidote is often arranged in zones, and in very many cases a large amount of the mineral is concentrated in a rim within the feldspar slightly removed from the edge, as is shown in Fig. 2. The interior of such feldspar crystals contains less epidote, and shows clearly the twinning lamellæ. More rarely the epidote concentration occurs at or near the center of the feldspar.

Since the zonal arrangement of the epidote occurs in plagioclase feldspars composed of a mixture of the albite and anorthite molecules, its explanation must be sought in variations of chemical composition within concentric zones of a single feldspar crystal. Such variations have been proven to exist and have been carefully described by Höpfner* and Becke,† who noted the fact that, while in the main, zonal feldspars grow more and more acid from their centers outward, there is, nevertheless, a frequent recurrence of zones more basic than some of those within them. Hence there is often more or less irregularity in the succession or arrangement of zones especially rich in the lime molecule, which is probably caused by oscillations of the physical conditions within the magma previous to its solidification.

Exactly what the chemical and physical conditions were which brought about so extensive a development of epidote within the feldspar of the Rowlandville granite, it is quite impossible to say. That it has been in some way connected with the action of the orographic pressure to which these rocks were subjected, appears altogether probable, especially



FIG. 2.—Plagioclase feldspar, twinned, and showing rim of epidote near the border of crystal. x 80.

*" Ueber das Gestein des Monte Tajumbina," Neues Jahrbuch, p. 182, 1881 (2).

†" Petrographische Studien am Tonalit der Rieseferner," Tschermak Min. Mitth XIII, p. 414, 1893.

since similar granites farther south, which have not been so squeezed, are relatively free from epidote. Nevertheless, the *chemical composition* of the feldspar seems, on the whole, to have had more influence on this particular form of alteration than the external forces acting upon it. Extreme dynamic action seems rather to have hindered than favored the formation of epidote, as is seen by comparing the Rowlandville with the more intensely foliated Port Deposit region; while other Maryland granites whose feldspar is mainly orthoclase, contain little or no epidote, even where they were more sheared than at Rowlandville. In this case here under consideration the feldspar is principally plagioclase, and this cause more than any other seems to account for the epidote development. The undoubted causal relation which exists between the zonal structure of the feldspars and their alteration, whereby these zones richest in lime have been most completely changed to epidote, also greatly favors this view.

Becke, in his recent work quoted above, shows that the outer zone of his tonalite feldspars is always albite. This seems in the rocks here described also to be the case, and this outer zone is almost entirely free from the secondary epidote.

In many localities physical conditions favorable to epidotization on a grand scale are known to have obtained, where the material acted upon was suited to this alteration. In other localities, on the contrary, quite the same material was changed in an altogether different manner. The operation of such conditions favorable to epidotization is nowhere better seen than in the basic volcanic rocks of the Blue Ridge in Maryland. Similar conditions must also have once prevailed in the Rowlandville area, while the composition of the feldspar in the granite furnished material in which this change readily progressed.

The change of feldspar into epidote has often been mentioned in the literature, and good lists of such references are given by Inonstranzeff,* Roth,† and Schenck.‡

Epidote Needles.—The epidote which has been described in the foregoing paragraphs as replacing feldspar, also occurs in

*Studien über Metamorphosirte Gesteine in Gouvernement Olonez, p. 188, 1879.

†Allgemeine und Chemische Geologie, Vol. I, p. 310, 1879.

‡Diabase des Oberen Ruhrthal, p. 28 1884.

the form of small needles in biotite, quartz, and occasionally in feldspar. The larger masses, as we have seen, are very irregular both in form and arrangement. These smaller particles, however, have a definite form and usually a symmetrical arrangement. These needles are especially characteristic of the biotite in very many sections of the Rowlandville granite. Basal sections of the mica are most favorable for their study where the needles cross each other, forming a network whose angles are 60 and 120 degrees, so that they resemble very strongly the well-known sagenite network of rutile needles (see Fig. 3, A and B). In prismatic sections

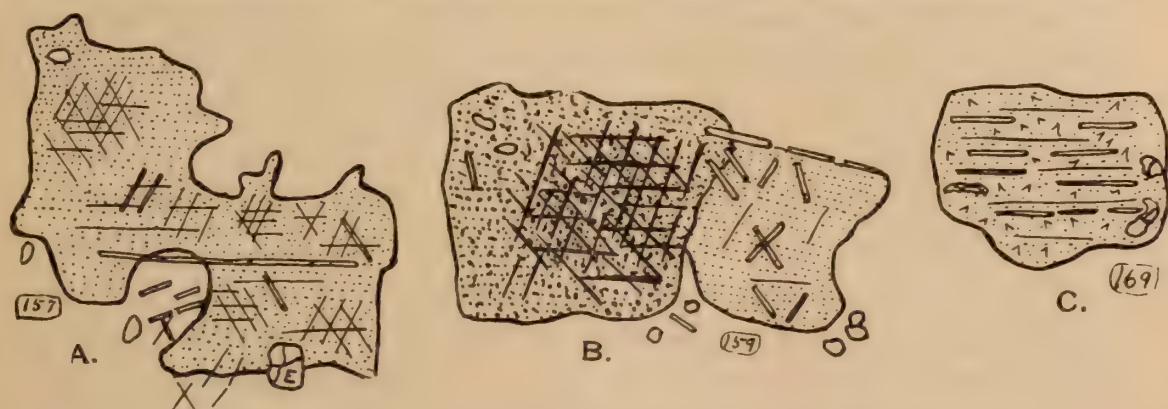


FIG. 3.—Epidote needles in biotite from Rowlandville granite.

of the biotite, they are seen along the line of the basal cleavage, and also in directions which make varying angles with these, as shown in Fig. 3 C. These needles, in some cases, extend unbroken from the biotite into the neighboring feldspar, preserving the same sixty-degree angles.

In the quartz, small needles also occur, which traverse this mineral in different directions. At the boundary between two contiguous grains of the quartz mosaic, these needles are broken. Even within a single quartz grain they are also generally broken and pulled apart (see Fig. 1).

In what has preceded, these needles have been described as epidote, without any reference as to proof of their mineral nature. At first glance they are suggestive of the sagentic arrangement so common in needles of rutile. Their shape and high refractive index also seem to indicate that they belong to this species. Closer study, however, with high magnifying powers, lead to the conclusion that these needles are really epidote, like the irregular grains with which they

are associated. The largest of these needles occur in the quartz where they are not only in close proximity to undoubted epidote, but here they can also be seen to be projections from epidote grains. These larger needles are traceable into those of smaller and smaller dimensions, until they seem even to merge into the hair-like inclusions represented in Fig. 1. The fact that, occasionally, a somewhat inclined extinction is observed in these needles is better in accord with a monoclinic rather than a tetragonal system of classification. That these needles should occur as a hexagonal network in the mica, though not before noticed, need excite no surprise. It is well known that mica often exerts an orienting effect upon acicular crystals included in it, even when these are of secondary origin. Hollrung,* for instance, figures and describes similar crystal needles in rubellan, where they also intersect at angles of sixty degrees. These, he is inclined to believe, are rutile. Lacroix† also described as rutile those minute needles which cause the asterism of the Canadian phlogopite. Brush‡ describes inclusions of magnetite, with hexagonal arrangement in the mica of Pennsbury, Penn.

Such hexagonally-arranged inclusions in mica usually follow the direction of pressure lines (Ger. *druckfiguren*), which are probably also solution planes of this species in sense in which this term is used by Judd. An attempt was made to decide whether this was also the arrangement in the present case, but the results were not conclusive, because of great difficulty in securing good pressure figures in the minute scales of mica, where these hexagonally-arranged needles were visible. An occasional hexagonal-arrangement in the other minerals than mica, while at first thought indicating the influence of the needles themselves, is probably rather to be accounted for by the influence of mica, which has disappeared in the preparation of the section.

While, therefore, these needles bear a certain resemblance to others, which are usually interpreted as rutile, the weight of evidence, in the present case, seems to point strongly to

* *Untersuchungen über den Rubellan*, Tsch. Min. Mitth. V, pp. 315-318. Plate III, 1883.

† *Bull. de la Soc. Min. de France*, Vol. VIII, p. 99, 1885.

‡ *Amer. Jour. Science* (3), Vol. XLVIII, p. 361, 1869.

their being secondary epidote, which is, in other forms, so very abundant in these Rowlandville granites.

MUSCOVITIZATION.

The alteration of feldspar into muscovite is much less frequent in the Rowlandville granites than that to epidote; and when it does occur, it is small in amount. In such cases it presents a marked contrast to the epidote in a number of features. The mica usually has a definite form, occurring in small tabular crystals, often with ragged edges. While it sometimes agrees with the epidote in being arranged irregularly through the feldspar, it usually shows a decided tendency to follow the cleavage lines and twinning striæ of its host. The reason why certain feldspars alter into muscovite, while others alter into epidote, depends doubtless on differences in chemical composition. The whole process of muscovitization in the Rowlandville area, however, sinks into insignificance when compared with the extensive development of epidote.

PRESSURE EFFECTS ON THE DIFFERENT MINERALS.

The minerals which show the most marked effects of pressure are the two essential components, quartz and feldspar. The former is often broken into a coarse mosaic, as represented in Figure 1; though in a few cases a large plate of quartz remains intact or slightly fissured, but it always shows undulatory extinction and peripheral granulation. The feldspar often shows undulatory extinction, microcline borders, cataclastic structure, or peripheral granulation. In a few cases, the feldspar crystals are broken and pushed asunder. Other minerals also show the results of pressure. The biotite is often broken into irregular masses bunched together, in diversely oriented groups, while both the micas show bent and broken cleavage lamellæ. The apatite and magnetite crystals are occasionally broken and separated. Such deformations as are here noted show that the rocks of the Rowlandville area have been subjected to very considerable pressure, which resulted in a shearing action, causing the

minerals to slide along their borders. The crystals would yield at these points which are lines of weakness in the rocks, since the force of adhesion between contiguous minerals would be more easily overcome than the force of cohesion within the crystal itself. In a number of cases, as cited in this section, the force was great enough to also overcome this property of cohesion.

CHEMICAL COMPOSITION OF THE ROWLANDVILLE GRANITE.

For the chemical investigation of the Rowlandville granite type the specimen was selected which showed, under the microscope, the least alteration. This was collected in the railroad cutting at the edge of the town of Rowlandville. It is a dark-colored granitite, containing somewhat more than the usual proportion of biotite. It contains an abundance of idiomorphic plagioclase crystals, with zonal arrangement of epidote, considerable unstriated feldspar which also contains epidote, and abundant quartz. The needles above described are present both in the biotite and quartz. A complete chemical analysis of this rock was made by Dr. W. F. Hillebrand, of the United States Geological Survey, with the following result:

Si O ₂ ,	66.68
Ti O ₂, . . . . .	.50
Al ₂ O ₃ ,	14.93
Fe ₂ O ₃ ,	1.58
Fe O,	3.23
Mn O, . . . . .	.10
Ca O,	4.89
Sr O,	Trace
Ba O, . . . . .	.08
Mg O,	2.19
K ₂ O,	2.05
Na ₂ O,	2.65
Li ₂ O,	Trace
H ₂ O, below 110° C., . . . . .	.16
H ₂ O, above 110° C.,	1.09
P ₂ O ₅, . . . . .	.10
Total,	100.32

An attempt was made to calculate the proportionate mineral composition of this rock with the aid of what could be learned from its microscopical examination. Such a calculation could only be an approximation, for two reasons; First, because the exact composition of the individual minerals in the rock is not known. Second, because certain of the bases enter into two or more of the silicates. Although a little secondary muscovite occurs in the feldspar, this was ignored and the proportion of orthoclase was first calculated, assuming that all the potash was contained in this mineral. The soda was, in like manner, referred entirely to the albite molecule in the plagioclase. The magnesia was regarded as being confined entirely to the biotite. A small proportion of the lime (1%) was arbitrarily assumed to represent approximately the proportion of the anorthite molecule, while the remainder, with the exception of what was necessary for the sphene and apatite, was referred to the epidote. While some titanium may be present in the biotite, this element was assigned entirely to sphene, which was the only titanium mineral shown in the thin section. The residual silica represents the quartz, and the residual iron the magnetite.

For those minerals which have a definite composition like orthoclase, albite, anorthite, quartz, sphene, apatite and magnetite, the theoretical proportions of the constituents were used as given in E. S. Dana's System of Mineralogy. On account of the almost colorless character of the epidote, this mineral was assumed to be composed of the iron and alumina molecules in the ratio of 1 to 8.

The results of this calculation are given in the following table:

Sphene,	1.25 per cent.		
Apatite, . . . . .	.25	"	"
Magnetite, . . . . .	.35	"	"
Biotite,	14.00	"	"
Orthoclase,	12.25	"	"
Albite,	22.50	"	"
Anorthite,	5.00	"	"
Quartz,	29.50	"	"
Epidote,	14.25	"	"
Total,	99.35	"	"

WEATHERING.

As the percolating waters reached these rocks, the mineral constituents were further altered, resulting in such weathering products as chlorite, calcite, kaolin and iron hydroxide. *Chlorite* is common in nearly all the rocks as an alteration product of biotite and hornblende. It varies in character from pale fibrous masses to large strongly pleochroic crystals, and it fills the cracks of the other minerals, especially quartz and feldspar. *Calcite* is found in a few granites near the town of Rowlandville. *Muscovite* is formed often by the bleaching of biotite, and the intermediate stages can be followed, while *kaolin* results from the decomposition of the feldspar. *Iron hydroxide* is very abundant in the decomposed granites.

MICROSCOPICAL DESCRIPTION OF THE ROCKS OF THE
PORT DEPOSIT AREA.

III.

In chapter one, it was suggested that the staurolitic mica-schist, just south of Liberty Grove, be used as a division line in the granite area described in this paper. The rocks of the district north of this belt have been considered in the preceding chapter. The petrographical characters of the rocks in the Port Deposit area, or the region south of this zone, will now be given. The metamorphism in the northern area, as we have seen, is characterized by chemical change, while the rocks show but little structural alteration. The granites of the Port Deposit area, on the other hand, are characterized rather by structural than by chemical changes.

There are two main rock types in the Port Deposit area: the *granite*, or, more properly, the *granite-gneiss*, and the *diorite*, which occurs in narrow belts within the more acid rock.

GRANITE GNEISS.

This rock is of such economic importance that it calls for special attention. As to the proper designation of the Port Deposit rock there has been considerable difference of opinion, as it has been called a syenite, granite and gneiss. The presence of much quartz and the very small amount of hornblende which it contains show that it can not with propriety be called a syenite, either in old or new acceptation of that term. The word gneiss has been used in a very indefinite way, so that it is desirable to clearly define the term. In this paper the word gneiss will be used in a purely structural sense, to denote all feldspathic crystalline schists.* If the origin of such metamorphic feldspathic schists can not be determined, they are called simply *gneiss*; but if their origin

*The word schist is here used to include all holocrystalline rocks with a pronounced parallel or foliated structure. See A. Geikie, *Text-Book of Geology*, 3d Edition, p. 178.

can be determined, another term is prefixed to denote the rock type from which they have been derived. In this chapter it will be shown that the Port Deposit rock is probably of igneous origin, and that it has had a secondary foliated structure produced through dynamic metamorphism. Since it furthermore has both the chemical and mineralogical composition of a normal granite it is considered most suitable to designate it as a *granite-gneiss*.

The original character of this granite-gneiss was once very similar to that of the Rowlandville granite type already described, and it still contains the same essential minerals, such as feldspar, quartz and biotite. The more intense action of pressure has, however, here been to crush the constituents, and to produce cataclastic structures rather than to bring about mineralogical changes, such as epidotization.

The *feldspar* belongs to both the alkaline and to the lime soda series. There seems to be in the southern area a greater development of potash feldspar in the form of microcline than in the Rowlandville rocks. This mineral shows the characteristic cross hatching in basal sections, and it appears striated in other sections. Though it often occurs in masses of considerable size, it is more usually broken into smaller fragments. The plagioclase feldspar shows fine twinning lamellæ, and usually the sections have low extinction angles, which would suggest that it belonged to the albite oligoclase series. There is also present a considerable amount of untwinned allotriomorphic feldspar, usually much altered to muscovite and epidote, which may be orthoclase or untwinned albite. In some sections of this latter feldspar, there occur small more or less rounded areas of microcline. Undoubted examples of microperthite are comparatively rare. In some cases the feldspars form micro-pegmatitic intergrowths with quartz, where the grains of the latter mineral occasionally have a fan-like arrangement.

All these feldspars exhibit pressure effects. They show undulatory extinction and peripheral granulation. In some, the crushing, combined with chemical change, have caused a very considerable development of the albite mosaic, composed of very fine interlocking grains, which look not unlike quartz. The alteration products of this mineral are epidote and

muscovite. The latter is the more abundant, and is found especially in and near feldspar cracks and along cleavage lines. The alteration to epidote is never as complete as in the Rowlandville granites, and here, as there, the feldspar excites no apparent orienting influence on these small epidote grains.

The *quartz* in the Port Deposit granite gneiss is broken into a mosaic of interlocking grains of varying size. In some cases the mosaic is coarse, and then the grains usually show coarse and fine cracks. In other cases the grains are of very small size. This mineral contains numerous inclusions of iron oxide and minute dust-like particles. It also contains small needles like those described in the quartz of the Rowlandville granites, but they are here neither so abundant nor so well developed.

The *biotite* occurs in the form of a broken aggregate of dark brown pleochroic plates, associated with large fragments of epidote and sphene. In the fresh granite, as exposed in the quarries, these masses do not form continuous bands through the rock, but are arranged in disconnected groups. In the more weathered specimens the biotite forms parallel layers, and the rocks even in thin sections present a distinctly foliated appearance. The biotite bleaches to muscovite and also changes to chlorite.

The *muscovite* is usually secondary, and occurs in radiating tufts and irregular masses. In a few of the granites, this mineral occurs in large plates with bent cleavage lamellæ, and it is also bordered by fresh biotite. Such original muscovite, however, is very small in amount.

In addition to these essential minerals, there occur a number of accessory minerals similar to those found in the Rowlandville rocks. *Apatite* is seen in all the sections, both in cross section, and as small lath-shaped crystals. This mineral is much more abundant in these granites than in the Rowlandville rocks, while *zircon* is less so. *Sphene* of a gray opaque color is also a very abundant constituent. It occurs in lozenge-shaped crystals, irregular masses, and forms leucoxene rims.

Allanite is present in about one-quarter of the sections in small grains and crystals, and it is always surrounded by a rim of epidote.

One large crystal, over two millimetres in length, was observed in a thin section of the granite from McClenahan's quarry. The crystal has been cut normal to one of the optic axes, and it has an inclined extinction.

As is well-known, allanite crystals are usually elongated in the direction of their orthodiagonal axis like epidote, but usually with a more tabular development parallel to the orthopinacoid. This, taken in connection with the emergence of a single optic axis transverse to the direction of elongation,

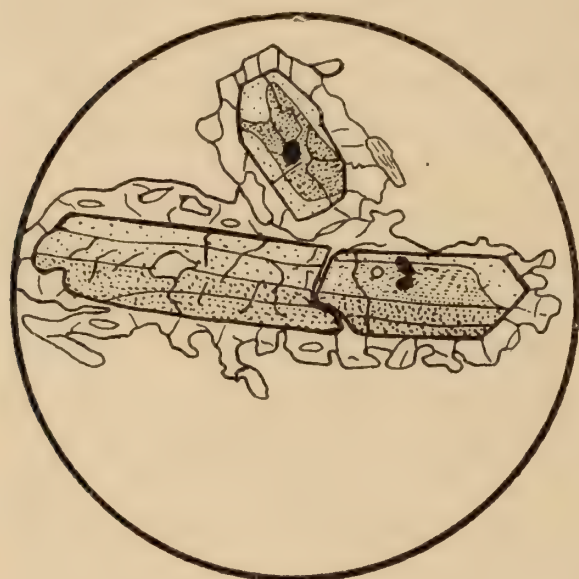


FIG. 4.—[35a.] Allanite crystal broken at the center, with epidote rim, and twinned parallel to orthopinacoid. $\times 80$.

would indicate that this section was approximately parallel to the base. This also accords with the trace of an orthopinacoidal twinning which traverses the section longitudinally (see Fig. 4). The variably inclined extinction, however, of from twelve to twenty degrees indicates that the section is really somewhat oblique to the basal pinacoid in the direction of the pyramid. The zonal structure is very prominent, and the interior is more deeply

colored than the narrow border. The pleochroism is strong and $b=b=\text{dark brown}$, $c=\text{yellowish brown}$. The optical character is negative. By the side of the large crystal is a smaller one which presents the same characters, but it is cut so as to show an optic axis in an excentric position. Both crystals contain inclusions of magnetite, and they exhibit numerous irregular cracks, which are sometimes continuous with those in the surrounding epidote, and in other cases are not. The large crystal is bent and broken near its center, and the fracture is filled with a mineral whose gray polarization colors suggest it to be calcite. On one side the epidote rim continues unbroken across the fissure, but this border possesses the same orientation as the allanite, and at one end of the crystal the two minerals seem to grade into one another.

The smaller crystal has at the border an undulatory extinction which passes across the epidote rim without any change. In all probability then the relation between the allanite and the epidote is the same as in the granites farther south, where Hobbs and Keyes described similar rims as probably original.

Among the other accessory constituents, *hornblende* is rarely present in bright green pleochroic crystals. *Magnetite*, as is shown by the magnet, on the other hand, is widely distributed in minute grains and large masses, which are often broken and pulled apart. In some of the granites there are numerous red *garnets*, which are filled with quartz inclusions and have the dodecahedral form, or in a few cases possess a rounded outline. *Epidote*, though found in the coarse-grained granites, is never as abundant as in the Rowlandville rocks, while in the squeezed granites where the ground mass is very fine, little or no epidote is seen. *Chlorite* occurs often in large amount, and in some cases is intimately associated with epidote, forming a chlorite epidote aggregate, the latter mineral is in a few specimens arranged in compact groups of needles in the chlorite. *Calcite* is not often present, and is associated with other decomposition products, as iron hydroxide and muscovite.

CHEMICAL COMPOSITION OF THE PORT DEPOSIT GRANITE-GNEISS.

On account of the economic importance of the granite-gneiss in the Port Deposit quarries, it was thought advisable to determine the relative proportions of the different minerals in it. This has been accomplished in two ways: First, by a mechanical separation of the constituents by means of the Thoulet solution; and second, by a chemical analysis. The results of the first method are only approximate, because the admixture of secondary minerals with the feldspar caused this mineral to fall through a very considerable range of specific gravity.

A chemical analysis of the granite-gneiss from McClenahan's quarry was made by Mr. William Bromwell, in the chemical laboratory of the University, with the following result:

Si O ₂ ,	73 69
Al ₂ O ₃ ,	12.89
Fe ₂ O ₃ ,	1.02
Fe O,	2.58
Ca O,	3.74
Mg O, . . . . .	.50
Na ₂ O,	2.81
K ₂ O,	1.48
H ₂ O,	1.06
Total	99.74

The proportionate mineral composition was calculated from this analysis in the same way as that of the Rowlandville granite, and the remarks made on that calculation apply likewise to this one. Since the epidote occurs only in small amount, one per cent (1%) of the calcium was arbitrarily assigned to this mineral, and the remainder is thought to belong to the anorthite molecule. From this calculation, taken in connection with the specific gravity separation, and a study of the relative areas occupied by these minerals in the thin sections, the following percentages are thought to fairly represent the rock :

CALCULATED PERCENTAGES, FROM CHEMICAL ANALYSIS.		PERCENTAGES OBTAINED BY SPECIFIC GRAVITY SEPARATION.	
Quartz.....	40.0	Sp. gr.	
Orthoclase.....	9.0	2.65 (Quartz)	40.0
Albite molecule	23.8	2.55-2.64 { Feldspar, }	45.0
Anorthite "	13.6	2.67-2.8 { Biotite, }	15.0
Biotite	9.7	Above 2.8, { Epidote, }	
Epidote.....	3.9		

STRUCTURE.

It is clear, from what has gone before, that both the Rowlandville and Port Deposit rocks accord in their geological occurrence, as well as in their chemical and mineralogical composition, with igneous granites. Both of them have, since their solidification, undergone extensive alteration, but, as has been already pointed out, this consists, in the Rowlandville area, mainly of chemical changes without much effect

upon the massive character of the rock, while in the Port Deposit area the structural changes are much more pronounced than the mineralogical.

The maximum dynamic action took place near Port Deposit, where it was sufficient to bring about a more or less complete recrystallization of the constituents and to superinduce a decided parallel structure. Thus, the biotite was not only recrystallized but rearranged under the influence of shearing, so as to produce the foliation which is the especial feature of this granite-gneiss. The evidence of mechanical action upon the constituent minerals, in the way of optical disturbance, bending and breaking of the grains, peripheral granulation, and the like, is very much more distinct than in the granites further north, and seem to be, in a way, inversely proportional to the epidotization of the feldspar. From a careful study of this rock, and a comparison with material from other regions where eruptive granites have been clearly shown to be changed by subsequent dynamic action into granite-gneisses, the conclusion that the foliation of the Port Deposit rock is a secondary feature seems to be abundantly warranted.

The secondary structure thus developed belongs to that type of gneissic arrangement which the Germans have called *flasrig*. The structure of the Port Deposit granite-gneiss seems to be intermediate between Nauman's types of *körnig-flasriger-Gneiss* and *flasriger-Gneiss*.^{*} This term has no exact English equivalent, but it may be translated as *lenticular*. The arrangement, which is better shown macroscopically in the ledge and hand specimen than in the thin section, though it is clearly distinguished under the microscope, is caused by a series of compressed biotitic lamellæ, more or less interlocking, and arranged in wavy layers. The small mica groups are disconnected, but they lie in approximately parallel lines. This foliation stands nearly vertical, and its direction is north-east, thus conforming both to the main structural features of the region and to the direction of the principal joints.

Two other structures are seen under the microscope, namely, the micro-porphyritic and the micro-pegmatitic. Though the first of these is of rare occurrence, the second is

^{*} Nauman Geognosie, Vol. I, p. 546, 1858.

frequently observed. The micro-porphyritic structure is seen only in a few cases, and it is probably best shown in the granite which is exposed in the ravine cut by the little stream one-half mile north of Frenchtown. In the thin section of this granite large feldspar individuals are imbedded in a fine granular quartz-feldspar ground mass, while the rock shows less effects of metamorphic action than those further north.

The intergrowths of quartz and feldspar, which form the micro-pegmatite, are seen in small amount in nearly all specimens. In the most foliated granites these quartz-feldspar aggregates have been broken into small masses. The resulting fragments show the effects of pressure, especially in the quartz which is optically disturbed.

DIORITE.

The occurrence of dark dioritic bands following in the main the strike of the granite-gneiss, although in some instances cutting abruptly across it, has been mentioned in chapter one. There is much in the field occurrence of these rocks to suggest that they are metamorphosed and uralitized projections, or dykes from the large gabbro masses on the north and south-west. The microscopical examination tends to further strengthen this hypothesis. In their mineralogical composition these rocks are now foliated diorites, or hornblende gneisses, composed essentially of secondary hornblende, plagioclase and quartz, and containing in addition varying amounts of biotite, orthoclase, garnet, rutile and other accessory constituents. As alteration products, they also exhibit epidote, chlorite, calcite, etc.

These dioritic bands, which are principally exposed along the river bluff, are divisible into three groups. First, those occurring within the town of Port Deposit; second, the three belts visible between Port Deposit and Frenchtown, in the vicinity of Herring Run; third, the belt of gabbro diorite, near Frenchtown, in connection with which will be considered a belt of very similar rock cutting across the strike of the granites near Harrisville.

The microscopical examination of these basic rocks shows that the zone of maximum dynamic action for them agrees very closely with that for the surrounding granite-gneiss.

Port Deposit Series.—In the belt of black rock along the road, which leads out of the center of the town of Port Deposit, a number of specimens were collected. Macroscopically, these appeared to be typical hornblende gneisses (1, 8, 10). In one specimen (10) the banded appearance was found to be due to secondary epidote arranged along certain layers. Microscopically these rocks possess a decided foliated structure, and the quartz, orthoclase and plagioclase are mostly crushed into a fine mosaic.

The *hornblende* shows no pressure phenomena, but it is often pitted with small quartz grains, and in other ways manifests its secondary origin. It is of a bright green color, strongly pleochroic, a light yellow, b greenish yellow, c bluish green. The absorption is $c > b > a$. *Magnetite* is also present in considerable amount. *Epidote* is sparingly developed in the feldspar of sections one and eight, and so abundant in section ten as to rival the hornblende in prominence. *Rutile* is present in very small amount.

Along the Rock Run road, at the northern edge of the town, the dark rock is essentially like the preceding, but shows somewhat less pronounced effects of crushing. The feldspars exhibit only disturbed extinction and a slight peripheral granulation, but they are more or less changed to secondary epidote.

Herring Run Series.—The first of the dykes in this region below Port Deposit is only a few feet in width. A thin section shows characters quite like the rocks of the last region, but with less hornblende, and with a considerable amount of irregularly-arranged epidote. The original constituents are completely crushed to a fine mosaic. The largest of these dykes is five hundred feet in width and shows great variations in grain. The diorite toward the edge of this wide dyke is a fine-grained rock, with less hornblende than the other two belts. The microscope shows beautiful crushing effects, which are seen in the elongated and broken quartz areas. The hornblende occurs in greatly elongated crystalloids, which follow closely the direction of foliation. Feldspar eyes are broken into a coarse mosaic filled with secondary epidote. Minute grains of titanite iron are surrounded by leucoxene rims, and there is a considerable development of secondary sphene.

The rock near the center of the dyke is less compact, and its weathered surface is dotted with hornblende needles. While not itself distinctly foliated, this rock is largely composed of finely fibrous secondary hornblende, much pitted with particles of quartz. In some cases, rocks from this dyke show the hornblende in disseminated acicular needles of great sharpness of outline, and often arranged so nearly parallel as to produce a foliation. Such varieties resemble the *nadel-diorit* of Guembel,* and not infrequently contain both biotite and chlorite.

Frenchtown Diorite.—In the thin section of the dioritic dyke (39) farther south, near Frenchtown, the foliation is less pronounced than in the last series. The hornblende occurs in decidedly uralitic crystalloids, of a pale green color, which grows darker toward the edges. This mineral forms a large proportion of the rock, and is undoubtedly secondary. The interstitial substance is almost entirely feldspar, which is changed to an aggregate of fine epidote grains. A little quartz is present, but no magnetite or other accessory minerals were noted in the section.

In a thin section of the Harrisville dyke the characters are found to agree very closely with those of the Frenchtown diorite. It, however, contains more quartz, and the hornblende is less fibrous. This last mineral shows similar darker peripheral portions. Biotite is present, and secondary epidote occurs in the feldspar in much larger masses than in the Frenchtown diorite.

The examination of the sections shows that all the specimens collected are *quartz-diorites*. These may be further divided into two groups: hornblende-quartz-diorite, which includes most of the thin sections, and biotite hornblende-quartz-diorite. There is nothing in their mineralogical composition opposed to the hypothesis that they are dynamically metamorphosed gabbros.

*Ostbayerisches Grenzgebirge, p. 349, quoted by Rosenbusch, *Massigen Gesteine*, p. 106, 1887.

IV.

THE STAUROLITIC MICA-SCHIST, AND THE ISOLATION OF THE RARER CONSTITUENTS OF THE CECIL COUNTY GRANITES.

In the preceding chapters, the petrographical description of the Rowlandville and Port Deposit areas has been given. In the first part of the present chapter the microscopical character of the staurolitic mica-schist which divides these two districts will be described, while in the second part the results of a study of the heavier minerals separated from the decomposed granites in various portions of the whole area will be presented.

I.—PETROGRAPHICAL DESCRIPTION OF THE STAUROLITIC MICA-SCHIST.

The field relations of the mica-schist, which occurs a mile south of Liberty Grove, have been discussed on page 66 of the present paper. It is a finely-crumpled rock, composed mainly of quartz and mica. A cleavage cuts across the folds, and in many cases it is quite prominent. These cleavage lines are slightly sinuous through a faulting of the mica laminæ which lie in the folds. The variety of cleavage so well shown in this schist is that described by Heim* as *ausweichungscleavage*, which is translated by Bonney as "strain-slip-cleavage," or simply "slip-cleavage," by Dale.†

The essential minerals of this schist are mica and quartz. The *mica* is of two kinds, muscovite and biotite, which are about equal in amount. It occurs in narrow plates, which lie in the folds of the schist. In the process of the folding, these mica crystals have been bent, crumpled, and broken, and in many places a slight faulting was produced, resulting in the slip-cleavage. The *quartz* occurs as a mosaic of interlock-

* Mechanismus der Gebirgsbildung, Vol. II, p. 53.

† Amer. Jour. Science, Vol. XLIII p. 317, 1892.

ing grains of varying size, which fill in the space between the mica bands. This mineral contains small dust-like inclusions, also magnetite and chlorite.

In the portion of the schist exposed in the valley of Basin Run staurolite crystals are very abundant. When these crystals are studied under the microscope they are seen to be completely changed into an aggregate of brightly-polarizing white mica scales, which are associated with chlorite and quartz grains. The quartz in the altered staurolite represents the original inclusions of this mineral in the staurolite, while the chlorite which is scattered through the altered crystals has wandered from decomposed garnets. No trace of the original staurolite remains, even in sections cut through the center of the crystals. The iron hydroxide resulting from this alteration of the staurolite has stained the mica, and outlined small areas of muscovite, which often have a radial arrangement. In some of the less altered crystals faint traces of a former brachypinacoidal cleavage were observed, but even this is obscure.

Staurolite has generally been considered as a very stable compound, and hence references to its alteration are comparatively rare in the literature. There are several mentions of its change to steatite, chlorite, and serpentine, but they are, probably, for the most part, erroneous.* The statement of Rand as to the alteration of staurolite to serpentine is certainly a mistake, as this mineral has recently been shown to be not staurolite but olivine.

The natural course of the alteration of staurolite seems to be to muscovite, and all well-authenticated descriptions which I have been able to find point to this conclusion. In 1871, Pichler† seems to have been the first to note this alteration. Thürrach,‡ in his studies on zircon, rutile, and associated minerals, found staurolite altered to white mica. Lacroix,|| in 1886, made a careful study of a mineral from Milltown, Scot-

* Roth: *Allgemeine und Chemische Geologie*, Vol. I, p. 384; E. S. Dana, *System of Mineralogy*, p. 560, 1892; H. Rosenbusch, *Mikros. Physiog. Mineralien*, Vol. I, p. 447, 1892.

† *Neues Jahrbuch für Mineralogie*, etc., p. 55, 1871.

‡ *Ueber das Vorkommen Mikroskopischer Zirkone, und Titan-Mineralien in den Gesteinen*, p. 45, 1884.

|| *Bull. de la Soc. Min. de France*, Paris, Vol. IX, p. 78, 1886.

land, which Heddle had described under the name of *xantholite*. Lacroix showed this mineral to be merely a staurolite whose composition was rendered variable through the presence of more or less mica. This staurolite also contained rutile in crystals of considerable size. Termier* noted in some staurolites from near St. Etienne (Loire), that the crystals were surrounded by a rim of white mica and chlorite which had resulted from their alteration, so that between cross nicols a thin section of the mineral was surrounded by a peripheral zone of bright colors. When the rim of mica was very wide, it was observed that the crystals were much corroded, and that many small fragments of unaltered material were scattered through the mica, all of which were similarly oriented, with the main part of the staurolite crystal. On account of the bright polarization colors of these mica pseudomorphs they have been called "shimmer-aggregates" by Barrow,† in his work on the gneisses in the south-east Highlands of Scotland. In the rocks of that region, this author noted that the replacement of staurolite by mica starts from the outside and then proceeds to the interior along cracks, so as to leave cores of the unaltered material. Barrois‡ noted in the Rostrenen granites an analogous change of andalusite and chiastolite to a fine-grained aggregate of white mica.

The fullest, as well as the most recent, description of this change is that given by Lacroix|| in his recent book on the mineralogy of France. He found, near Itsatsou, in the Lower Pyrenees, staurolite crystals which had altered to mica. The change was generally peripheral, but it followed the fractures and cleavage lines. The alteration was incomplete, for a corroded fragment of the staurolite always remained at the center. The mica plates reached an extreme length of one millimeter.

A chemical analysis of this altered staurolite in the Liberty Grove schist was made by Mr. George Steiger, under the direc-

* Bull. de la Soc. Min. de France, Paris, Vol. XII, p. 395, 1889.

† An Intrusion of Muscovite-Biotite Gneiss, Quat. Journ. Geol. Soc., Vol. XLIX, p. 340, 1893.

‡ Le Granite de Rostrenen, Societe Geologique du Nord, Vol. XII, pp. 57, 69, 80, 91, 1884.

|| Mineralogie de la France et de ses Colonies, p. 5, with figure, 1893.

tion of Professor F. W. Clarke, of the United States Geological Survey, with the following result :

Si O ₂ ,	50.17
Ti O ₂, . . . . .	.55
Al ₂ O ₃ ,	27.97
Fe ₂ O ₃ ,	6.13
Fe O,	1.18
Mg O,	1.15
K ₂ O,	7.77
Na ₂ O, . . . . .	.48
Water below 100°, . . . . .	.42
Water above 100°,	3.94
P ₂ O ₅, . . . . .	.06
Total,	99.82

This analysis represents, approximately, the following percentages of constituent minerals :

Muscovite,	72.7
Quartz,	17.3
Magnetite and Iron Hydroxide,	8.4
Other impurities (rutile, apatite, etc.),	1.6
Total,	100.0

According to the recent analyses of Penfield the composition of fresh staurolite has been established as either Al (Si O₄)₂ (AlOH)₄ (FeOH) or Fe (Si O₄)₂ (AlOH)₅. The breaking down of this mineral into muscovite, with the separation of iron hydroxide and the loss of alumina, speaks in favor of the first of these formulæ. The theoretical composition of the two minerals are as follows :

STAUROLITE.		MUSCOVITE.	
H Al ₅ Fe Si ₂ O ₁₃ .		(KH) Al ₂ Si ₂ O ₈ .	
Si O ₂ ,	26.32	Si O ₂ ,	45.2
Al ₂ O ₃ ,	55.92	Al ₂ O ₃ ,	38.5
Fe O,	15.79	K ₂ O,	11.8
H ₂ O,	1.97	H ₂ O,	4.5
Total	100.00	Total	100.0

We may represent this change structurally in the following manner:



which, while of course hypothetical, does exhibit the relation between the staurolite and its observed alteration products.

A number of other accessory minerals occur in this schist, as garnet, magnetite, tourmaline, apatite, rutile and chlorite.

Red *garnets* are seen both in the schist and the staurolite. They are filled with small quartz inclusions, and usually show a more or less complete alteration to chlorite. In some of the crystals there is a narrow peripheral rim of chlorite, which increases in size, at the expense of the garnet, until only a small core of the original mineral remains. The chlorite forms such a perfect pseudomorph that the original dodecahedral outline of the



FIG. 5.—Garnet, with quartz inclusions, altering to chlorite.

crystal is preserved (vid Fig. 5). The alteration of garnet to chlorite has frequently been referred to in the literature, and good references to such a change may be found in the works of Roth* and Rosenbusch.†

Magnetite, as proven by the magnet, occurs in minute dots or grains, and often with crystal form in both the schist and the staurolite. It seems to be more abundant in the latter mineral, and it is often grouped together so as to form skeleton crystals.

Tourmaline is present in the schist and staurolite in small pleochroic, hemimorphic crystals, but it is never in large amount.

*Allgemeine und Chemische Geologie, Vol. I, pp. 353-363.

†Mikroskop Physiographie der Mineralien, Vol. I, p. 447, 1892.

Rutile was not observed in the schist, but it occurs in the staurolite in short crystals in considerable amount.

Chlorite is more abundant in the schist than in the staurolite, and while much has originated from the decomposition of the garnets, more has probably come from the bleaching of the biotite. The presence of a strongly pleochroic biotite lends weight to this opinion.

In the quartz of the staurolite occur small elongated colorless crystals which were thought to be *apatite*, and the presence of phosphoric acid, as shown by the analysis, adds weight to this opinion.

II.—ISOLATION OF THE RARER CONSTITUENTS OF THE CECIL COUNTY ROCKS.

In the second chapter of this paper, it was noted that the granite exposures, along the road sides and in some of the creek banks, are so much weathered as to conceal the hard rock with a stratum of soil of varying depth. It is impossible to study these granites in thin sections. One is able, however, in such cases, to separate out of this earth a fine residue containing the rarer and heavier minerals of the granite. This may be accomplished by a separation through specific gravity in water, a process which is valuable in concentrating minerals that are sparingly distributed in the solid granite.

Thürach* first recognized the value of such separations, and by this means he made a study of the rarer constituents of many Central European rocks. He washed the powdered rock with water in porcelain dishes, allowing the lighter minerals to pass over the edge of the dish with the liquid, which was thrown out by a quick motion of the hand. His study of residues thus obtained added much to our knowledge of the heavier rock constituents. A more convenient apparatus was employed by Derby† in Brazil, and the mode of procedure, though used without any knowledge of Thürach's work, is almost the same.

In the study of these decomposed granites of Cecil County, I have used the apparatus suggested by Professor Derby,

*Zirkone und Titan Mineralien in den Gesteinen (1884).

†Described very fully in Proceedings Rochester Academy of Science, Vol. I, p. 198, (1891).

which is an ordinary shallow miner's pan or bateâ of twelve inches diameter, and with an apical angle of 120 degrees. It is best made of a single piece of spun copper, so as to leave the interior perfectly smooth. In this pan is placed the powdered rock or soil mixed with water. The mixture is stirred thoroughly, and the water with the earthy portion in suspension is poured off. The granular portion so left is stirred again in the liquid, by a combination of a spherical and elliptical movement of the pan, which the hand soon acquires. Then, by a quick side movement, the water is thrown off, carrying the lighter minerals and the floating mica. After several repetitions of this process, accomplished in a few minutes, a small residue remains, which is mounted either in balsam or water and placed under the microscope. This method was applied to the decomposed granites at different places within the granite area, and a number of facts were thus brought to light which none of the thin sections revealed.

The decomposed granites from five separate localities were examined by this method. Three of these were near Liberty Grove, one at Port Deposit and one near Perryville. To the south of Liberty Grove, near the staurolite zone, there is a bluff of decomposed granite by the side of the road, where the first material was obtained. Small hemimorphic crystals of *tourmaline* were found in the residue. *Allanite* was abundant in small crystals, and it was also observed as an inclusion in quartz. This mineral is strongly pleochroic, being deep brown in the long direction and yellowish brown at right angles to this line. *Zircon* is less abundant than at other localities, and contains inclusions thought to be magnetite. Large wine-colored *garnets* are scattered through the residue. Other minerals noted in this soil were *sphene*, in large lozenge-shaped sections (see Figure 6), small rutile grains, with reddish yellow color. All the minerals of this soil were more or less stained with iron hydroxide.

In the granite soils further north, and especially in a weathered bluff by the road, one-half mile north of the last locality, *zircon* becomes the predominant mineral in the residue, though it is only sparingly represented in the thin sections. The crystals present a variety of colors, being yellow, red and colorless. They occur in long narrow

crystals with the faces ; OP (001), P (111), ∞P (110), to which are sometimes added $\infty P\infty$ (010) and $3P_3$ (131). They are usually broad and stout, and form inclusions in the quartz and tourmaline. In a few instances they show a zonal structure. In these zircons occur, as inclusions, a dark mineral, probably magnetite, and small colorless lath-shaped crystals like those which Thürach found and showed to be apatite by isolation and treatment with ammonium molybdate, an observation that is interesting in showing the apatite to be older than the zircon. Crystals of this mineral, free from inclusions, are rare in these residues. A number of crystals are represented in Figure 6. Other minerals, which occur in these northern granite residues, are sphene, allanite, garnet and magnetite in good crystals. The latter mineral is so abundant in many of the residues that it obscures the other minerals unless removed with a magnet.

In the quarry at Port Deposit a considerable amount of powdered rock was obtained from under the sieves of the stone crusher, and its residue after washing contained zircons in large number with the apatite inclusions, also allanite and garnets.

A striking peculiarity of the garnets obtained in these granitic residues, especially in those of Port Deposit and Perryville, is a more or less pronounced cubic form. While many garnets show the common dodecahedron, with no other planes in combination, these crystals offer a distinct contrast in their hexahedral development. Their faces are never sharp planes, but are more or less rounded, as though by a tendency to the development of the tetrahexahedron, as shown in Figure 6. When the extreme rarity of cubic faces on garnets is considered, this occurrence seems worthy of special note.*

On account of the interest attached to the staurolite mica-schist zone, it was also thought advisable to make a study of the sand and soil near it. The residue, after the washing, contained a large number of minerals. Hemimorphic crystals of *tourmaline* of varying size were especially prominent. Some of these crystals were small and stout, being nearly

*I am informed by Professor Derby that he has discovered similar cubic garnets in the granitic residues which he has washed in Brazil.

equal in length and breadth, while others were columnar. They usually show the rhombohedron at one end, the basal plane modified by the rhombohedron at the other extremity. All were strongly pleochroic, C light yellow, and in the direction at right angles to the principal axis, a deep brown. These tourmalines contain a variety of inclusions, as magnetite, small stout crystals resembling zircon, and others which could not be determined. The tourmaline also forms inclusions in the quartz. Irregular cracks occur parallel to the basal plane and rarely parallel to a prism, as shown near the center of Figure 6. A number of these hemimorphic crystals are shown in Figure 6. *Magnetite* and dodecahedral *garnets* are less abundant than tourmaline. Green *hornblende* also occurs in prismatic and cross sections. This mineral was not noted in the thin sections.



FIG. 6.—Crystals in the granite and staurolite schist residues. Z, zircon; G, garnet, T, tourmaline; St., staurolite; M, magnetite; A, apatite; Sp., sphene. x 80.

Most remarkable of all was the abundance of bright yellow and reddish-yellow crystals, with parallel extinction, and whose optical properties seemed to accord with those of *staurolite*. These crystals are usually strongly pleochroic (see Figure 6). It will be remembered that in the microscopical study of this zone, the staurolite crystals were always completely altered to mica, even to the center.

V.

GENERAL CONCLUSIONS AND SUMMARY.

From the preceding field and laboratory study of the granitic rocks exposed along the northern bank of the Susquehanna River in Maryland, the general conclusion is reached that, in spite of an often pronounced foliated structure, they are truly igneous masses, similar to those occurring in the crystalline Piedmont belt farther south, whose eruptive origin is more apparent. Granites, showing a considerable range in chemical and mineralogical composition, are widely distributed through the ancient crystalline belt along our Atlantic border. That these rocks vary greatly in age, is seen from the fact, that while some of them have been extremely metamorphosed by dynamic processes, others are almost entirely unchanged.

The proofs of the eruptive character of the youngest, and hence the least altered, of these granite masses, as well as of many more basic areas occurring with them, are altogether convincing. Branching dykes and apophyses penetrating the adjoining schists and gneisses, large irregular fragments of the enclosing rocks torn off and wholly included within the eruptives, as well as pronounced evidence of contact action around them, bear ample witness to their igneous origin. In the case of older rocks of similar character, such decisive proofs of eruptive origin must necessarily become less and less distinct in proportion as the rocks have become foliated and metamorphosed. We are, therefore, compelled, when dealing with the more ancient of these intrusive rocks in our Pre-Cambrian belt, to reason somewhat from analogy, association and mode of geological occurrence, reconstructing as well as may be from evidence now at hand what was probably the original condition of such masses.

In the case here under consideration, the rocks north of the staurolitic mica-schist belt have been least altered, and

hence approach most closely to the type of the normal and undoubtedly igneous granites. In reviewing the evidence now available as to the original character of these rocks, we may conveniently arrange the matter under several heads. We shall, therefore, summarize in succession the proofs of igneous origin based upon, 1, chemical composition; 2, mineralogical composition and structure; 3, geological mode of occurrence; 4, contact action.

1. *Chemical Composition.*—While the two analyses made of the Rowlandville and Port Deposit granites differ considerably in their silica percentage, they both agree in the proportion of their chemical elements with igneous granites; hence, while this of itself can not be regarded as a definite proof, it is in accord with the theory of igneous origin, since, as Rosenbusch* has pointed out, it is only by an accident that sedimentary deposits may have the bulk composition of igneous masses. As a rule, such sedimentary deposits would vary considerably from eruptive types, and as there is reason to believe that the bulk composition of a rock is not greatly changed by its metamorphism, we may regard the chemical analyses of the Cecil County granites as at least indicative of their igneous origin.

2. *Mineralogical Composition and Structure.*—The minerals which compose the rocks under consideration are those which most commonly make up the substance of normal eruptive granites. Feldspar, quartz and biotite are their essential constituents in about the same proportion as are ordinarily found. They are free from those minerals like andalusite, cyanite, staurolite, cordierite, etc., which are so characteristic of metamorphosed sediments, while garnet is known to be readily produced by the metamorphism of igneous as well as of sedimentary material.

Allanite is a widely distributed constituent in these rocks, both in the form of crystals and small grains. While the presence of this material was formerly regarded as good proof against eruptive origin, because it was thought to be unable to stand high heat, the investigations of Scheerer, Daubree and others, have shown the fallacy of this argument.

*Zur Auffassung der chemischen Natur des Grundgebirges *Tscher Min. und Petrog. Mitth.*, Vol. 12, p. 49, 1891.

It is now generally conceded that this cerium-epidote represents a direct crystallization from an original magma, and its presence forms a good proof of eruptive character.

At a number of localities in this Cecil County area, there occur numerous dark, oval areas in the granite, which all the evidence at hand seems to show are segregations of the more basic constituents of the acid rock. Such a phenomenon must have taken place in the magma while it was in the process of cooling, and so would point to an original molten state. The structure of these rocks, also, in so far as it has not been entirely remodeled by dynamic action, is that commonly observed in igneous granites, while the sequence of crystallization in the different minerals also accords with this view. In the main, the structure is hypidiomorphic granular, but this shows a frequent tendency to develop micro-porphyrific facies, or inclines to micro-pegmatitic intergrowths of quartz and feldspar. That the structure of some of these granites was more or less miarolitic is shown by the presence of interstitial calcite.*

3. *Geological Mode of Occurrence.*—A study of the granite-gabbro contact along the road from Rowlandville to Porter's Bridge seems to show that the granite is the younger rock, but in the Port Deposit region the granite-gneiss seems to be older than the gabbros, as represented in the gabbro-diorite dykes. It may be that the Rowlandville granite is much younger than the Port Deposit granite-gneiss, and the two eruptions were separated by a period of great disturbance, which resulted in the foliation of the Port Deposit granite. The contact above mentioned is that of an undoubted eruptive rock, the granite penetrating the gabbro in small dykes, and including fragments of the basic rock. There is nothing in the field relations of these rocks which militates against the idea of their being intrusive masses.

4. *Contact Action.*—One of the best indications that the granite rocks of Cecil County are of igneous origin is the occurrence of the staurolitic-mica-schist belt between the Rowlandville and Port Deposit areas. There is good evidence for believing that the material of this schist is of sedimen-

* Rosenbusch: Die massigen Gesteine, p. 34, 1887.

tary origin, and the minerals which have been so extensively developed in it are just those which we might suppose would be developed by the action.

II.—SUMMARY OF RESULTS.

The most important general conclusions derived from the foregoing study of the granitic rocks in Cecil County, Maryland, may be briefly summarized as follows:

1. The granitic rocks are to be regarded as eruptive masses, which have been variously modified by dynamic agencies.

2. The division of the area studied into two portions, divided by the belt of staurolitic mica-schist, is shown both on structural, chemical and mineralogical grounds to be well founded.

a. The rocks near Port Deposit are much more gneissoid and foliated, and hence represent either an older intrusion or a zone of maximum dynamic action.

b. While the chemical analyses show marked differences in acidity, this is hardly to be relied upon as representing the differences in average bulk composition between the two areas, since the specimen selected from near Rowlandville was unusually dark and rich in biotite.

c. The alteration of feldspar in the northern or Rowlandville area is mainly chemical, resulting in a change to epidote, while in the Port Deposit area it is more mechanical.

3. The dark patches appear to be basic segregations formed previous to complete solidification rather than inclusions of foreign rocks.

4. The most striking manifestation of metamorphism is the extensive development of epidote, especially in the Rowlandville area, in an acid plagioclase. The zonal arrangement of this mineral indicates a zonal development of original isomorphous layers of the feldspar substance.

5. The small needles with hexagonal arrangement, in biotite, quartz and feldspar, are to be regarded as epidote.

6. The staurolitic mica-schist, separating the areas, represents a sedimentary deposit more ancient than the granites,

and it probably owes its highly crystalline character to contact metamorphism, produced by them at the time of their eruption.

7. The staurolite in this mica-schist has altered completely to muscovite while the garnets are in process of alteration to chlorite.

8. The study of granite soils with the aid of the miner's pan showed the presence of a number of minerals not noticed in the thin sections. This method also showed a wide distribution of zircon, with good terminations and numerous inclusions. It also brought to light many garnets with a cubical outline.

THE ST. PETER'S SANDSTONE.

BY JOSEPH F. JAMES, M. SC., F. G. S. A., ETC.

INTRODUCTION.

In all geological investigations, rocks of any particular formation are noticed long previous to their differentiation under a distinct name. The reason is that observations are made by explorers and travelers in different portions of the country before the adoption of any definite system of nomenclature, and facts are recorded without a reference of the rocks to any special horizon. Therefore, although the St. Peter's sandstone is unknown as a formation with a distinct name in the geological column prior to 1847, references were made to it years previously.

The first reference to, and description of, rocks now known as the St. Peter's sandstone is given by Captain Jonathan Carver, in his travels through the interior parts of North America, in 1766-67-68. In this volume (p. 63) he gives an account of a cave visited by him, now known by the name of Carver's Cave. It is situated about thirty miles below the Falls of St. Anthony, and is an excavation in the St. Peter's sandstone. Carver found the stone so soft that it could be cut with a knife, and the walls of the cave were carved with Indian hieroglyphics. He also states that a little way from the mouth of the St. Peter's River is a hill composed entirely of white stone, the outer part of which crumbles into heaps of sand through the action of the weather.* This, also, is St. Peter's sandstone.

In 1817, Major Stephen H. Long visited the Falls of St. Anthony, and in his book he gives an account of the formations observed by him in Minnesota. One of these was a white or yellowish sandstone, which crumbled so easily as to deserve the name of sandbank rather than that of sandstone.

*Ibid, pp. 100, 101.

It is stated to underlie the limestone that forms the brink of the Falls. "It is of various depths, from ten to seventy-five feet."*

In 1820, H. R. Schoolcraft was sent by the general government on an expedition to the sources of the Mississippi River, and he submitted a report of his observations in 1821. This was republished in 1855,† and in this volume he refers to the geological features of St. Anthony's Falls, where the river is precipitated, at one leap, over "strata of white sandstone, overlaid by the metalliferous limestone. * * This sandstone is composed of grains of pure and nearly limpid quartz, held together by the cohesion of aggregation. If my observations were well taken it embraces, sparingly, orbicular masses of hornblende. It is horizontal, and constitutes, in some places, walls of stratification, which are remarkable for their whiteness and purity."‡ This is, undoubtedly, the St. Peter's sandstone.

In 1824, Professor Keating|| gave a section of the strata as observed by him at Fort Snelling. In this a sandstone is mentioned as occurring beneath from twenty-five to thirty feet of limestone, and which constituted the principal mass of the bluff. He says: "This is friable, but every fragment, examined with care, seems *to be a regular crystal*." Keating inclined to the opinion that it must have been a chemical precipitate, and not a mere mechanical deposit. He says: "The process of its formation may have been a rapid one, such as is obtained in the manufacture of fine salt: and to this may be attributed the circumstance of its fine texture. The color is white, sometimes a little grayish, when it resembles the finer varieties of Muscovado sugar."§

In the report of Dr. John Locke, made in 1839,¶ in describ-

* Voyage in a six-oared skiff to the Falls of St. Anthony, in 1817. Minn. Hist. Soc. Coll., Vol. II, p. 36 (pub. 1860).

† Summary narrative of an exploring expedition to the sources of the Mississippi. Appendix VII, pp. 303-362. Philadelphia, 1855.

‡ Ibid, p. 330.

|| Narrative of an expedition to the source of the St. Peter's River, etc., performed in the year 1823, under command of Major Stephen H. Long. 2 vols, 1824.

§ Quoted in Vol. I of Final Report of Geology of Minnesota, 1884, p. 35.

¶ [Comparison of the geological formations of the lead regions of Iowa and Wisconsin, and the cliff formation of Ohio, Indiana, and Kentucky, with various sections.] Rept. of Geol. Expl. of part of Iowa, Wisconsin, and Illinois, by D. D. Owen, pp. 116-126. 26th Cong., 1st Sess., H. R. Ex. Doc., No 239, 1840.

ing a section as observed at Prairie du Chien, he notes the presence of a sandstone underlying a buff-colored limestone and called "soft saccharoid sandstone." It is stated to be made up of sharp, angular fragments of quartz, scarcely cemented together. It may be white or colored, and when so colored it is often strongly cemented. It is compared to coarse, common, unrefined sugar, and, though it is difficult to break off a piece without its crumbling to pieces in the hand, yet, in places, it crops out extensively, and seems to stand the weather as well as other strata which are used for building stone. It is here given a thickness of forty feet, although Dr. Locke says he did not see the base of the formation. In the section accompanying the paper this sandstone is represented as lying between a blue limestone (now recognized as Trenton) and the Lower Magnesian limestone.* In the description of the strata from the Blue Mounds to the Wisconsin River, this sandstone is again referred to as the same as seen at Prairie du Chien. "It is remarkable for having its upper surface at an exact and even plane, very nearly level. In an excavated area, where several ravines meet in the same valley, and with the eye at any point of the upper surface of this sandstone, all other points appear at the same plane, like an emptied lake, leaving a line of ice to mark its original height; even where the rock is covered by earth, the vegetation changes so abruptly in sort and color, at the surface of the sandstone, that the line may still be distinctly traced."†

On November 2, 1842, a paper by Dr. D. D. Owen‡ was read before the Geological Society of London. It was read in April of the following year before the American Association of Naturalists and Geologists. Dr. Owen notices the presence of a sandstone underlying conformably a blue fossiliferous limestone. The sandstone is "sometimes of a deep red and sometimes of a white color, and resembling loaf sugar. Beneath this succeeds a magnesian limestone." He also says he has never found any fossils in the sandstones.|| This for-

* Ibid, p. 123.

† Ibid, p. 124.

‡ On the Geology of the Western States of North America. Am. Jour. Sci., Vol. XLV., pp. 151-152, 163-165; Quart. Jour. Geol. Soc. London, Vol. II, pp. 443-447, 1846.

|| Ibid, p. 446.

mation he afterward described under the name of St. Peter's sandstone.

The first mention of the term St. Peter's, as applied to a geological formation, was made by Dr. D. D. Owen, in 1847.*

After referring to the formations of the Upper Mississippi, it is stated that in some high situations, as near Lake St. Croix, the strata are surmounted "by soft white sandstone, capped with shell limestones, such as form the upper portions of the hills on the Wisconsin River, near Prairie du Chien, and constitute the whole of the escarpment of the St. Peter's falls, as well as the bluffs on both sides of the Mississippi, from thence to Carver's Cave and St. Pauls; and, therefore, sometimes alluded to by us under the local name of the St. Peter's formation."† Thus, no specific description of the formation is given in this, the first place of reference. That this is the formation in question, however, there can be no doubt, inasmuch as in the following year the strata were described, and in 1852 the name St. Peter's was definitely adopted.

In the report of Dr. Owen, published in 1848,‡ this formation is called "F. 2 c." It is superimposed on the Lower Magnesian limestone, and is the rock which forms the base of the bluffs at St. Peter's, and likewise the lower nineteen feet of the Falls of St. Anthony. It is said to be remarkable for its whiteness, and to be made up of grains of limpid and colorless quartz. "It appears to be destitute of organic remains; at least none have as yet come to light. In the absence of these, it is difficult to say whether it ought to be considered as the terminating member of F. 2, or the inferior member of F. 3. Since, however, it appears to have been produced by a repetition of sedimentary action, similar to that which occurred just at the commencement of F. 2, I have thought it best to place it, for the present, as the terminating mass of that formation."|| In the series of sections

* Preliminary report of Progress of the Geological Survey of Wisconsin and Iowa up to October 11th, 1847. U. S. Land Office Report for 1847, pp. 160-173. 30th Cong., 1st Sess., S. Ex. Doc., No. 2.

† Ibid, p. 169.

‡ On a geological reconnoissance of the Chippewa land district of Wisconsin, and the northern part of Iowa, 1848.

|| Ibid, p. 28.

accompanying the report, the sandstone is represented as "F. 2? c," and as occupying a position beneath the lower shell limestone, and above the Lower Magnesian limestone.

In 1852, Dr. D. D. Owen* described the St. Peter's sandstone in almost the identical language used in the report of 1848, referred to above.

Having in this brief historical review given an account of the observations made upon the rocks previous to its receiving the name which it now bears, let us examine the formation somewhat more minutely as to its distribution, lithological characters, stratigraphic position and fossils.

DISTRIBUTION.

The St. Peter's sandstone is confined to a limited district in the upper Mississippi valley. It is found in the States of Minnesota, Wisconsin, Illinois, Iowa and Missouri, and possibly in the northern peninsula of Michigan.

In Minnesota it outcrops in an irregular line in the southeastern part of the State, extending north-west from the southern boundary to above Minneapolis, and south-west again to Martin and Jackson counties.

In Wisconsin it is found in a narrow strip running from the Menominee River, at the north-eastern boundary, to the southern boundary, occurring in patches wherever the rivers have cut into the superincumbent formations to a depth sufficient to reach it. It also outcrops to a limited extent in St. Croix and Pierce counties in the north-western corner.

In Illinois it is found in two isolated patches; one of these is on Rock River, near Grand de Tour; the other on the Illinois River, in La Salle County. It also probably underlies a part of the State, being only known by deep-well borings.

In Iowa it is found exposed only in the north-east corner, though its presence has been revealed in other localities by deep wells at from 1,100 to 1,200 feet beneath the surface.

*[Protozoic rocks in the northwest.] Geol. Survey Wisconsin, Iowa and Minnesota; and incidentally of a portion of Nebraska Territory. Philadelphia, 1852, pp. 69-71.

In Missouri the "Saccharoidal sandstone" has been correlated with the St. Peter's. It is known in several places along the Mississippi River. There has been considerable dispute as to the exact age of the Saccharoidal sandstone, but the latest examination of it by Dr. F. L. Nason* led to the conclusion that the division which has been made of first, or saccharoidal, second and third sandstones, and first, second, third and fourth magnesian limestones can not be maintained. He says the evidence is not sufficient to make more than one sandstone and one limestone formation. For the first he proposed the name of Roubidoux sandstone, and for the second the name of Gasconade limestone. It seems probable that the strata that have been referred to the St. Peter's in Missouri are Cambrian rather than Silurian.

Finally, in Michigan, it apparently occurs in a narrow strip running from the Menominee River to the Sault Ste. Marie, the Lake Superior sandstone having been considered by some authors to belong to this period also.

LITHOLOGICAL CHARACTERS.

In all its typical outcrops the St. Peter's sandstone presents the same characteristics, being a friable, coarse-grained sandstone, the grains cohering but slightly, except when permeated by carbonate of lime or various oxides of iron. It then becomes hard and indurated. In color it varies greatly, being white, red, brown, yellow, gray, pink, green, lilac, and also being frequently banded in an irregular manner. It occasionally shows stratification planes, and ebb and flow structure, and rarely, ripple marks. In thickness it varies from a thin layer to a stratum over two hundred feet thick, though the latter is infrequent. Its peculiar character and the supposed entire absence of organic remains have caused it to be regarded by some authors as a chemical precipitate rather than as of mechanical origin. We have already seen that Keating, in 1824, considered it to be the former. The same idea was advanced in 1858 by Prof. J. D. Whitney,†

*Geol. Sur. of Missouri, Vol. III, Dec., 1892.

†Geological Sur. Iowa, Vol. I, Part I, 1858, p. 341.

who says that if this quantity of quartzose sand be the result of the mechanical attrition of azoic rocks, that it is difficult to understand the absence of detritus which would come from the destruction of schistose, feldspathic and trappean rocks which make up so large a portion of the azoic series. "The uniform size of the grains of which the sandstone is composed, and the tendency to the development of crystalline facets in them, are additional facts which suggest the idea of chemical precipitation rather than of mechanical accumulation."

The later discovery of fossils, although in limited numbers, has now caused it to be generally regarded as of mechanical origin. Upon this point Prof. Chamberlin* says that "the existence of the remains of marine life demonstrates that the fossiliferous portions at least are submarine deposits, while the well-rounded character of the grains, the ebb and flow structure, the shaly laminations, the conglomeritic portions, and its relations to the adjacent formations, leave no doubt that it belongs to the common class of oceanic sand deposits."

ECONOMIC VALUE.

The purity of the sandstone and its peculiar character have rendered it of value in the manufacture of glass in certain localities. The fact of its being generally overlain by a heavy stratum of limestone, has given it even more value to mankind, inasmuch as it is the cause of many waterfalls which are utilized for manufacturing purposes. It is the cause, for example, of St. Anthony's Falls, which has been to Minneapolis a source of immense wealth. Prof. N. H. Winchell, in the first annual report of the Geological and Natural History Survey of Minnesota for 1872 (1873), page 92, says, that at present the "sandstone is not known to be used for any purpose within the State except for mortar for the local markets and as an engraving board for idle boys. Sometimes beer vaults are made in it along the river bluffs, and sewers for the drainage of the cities of St. Paul and Minneapolis are excavated through it, the overlying limestone affording a secure roof."

*Geol. of Wisconsin, Vol. II, 1878, p. 288.

THE BASE.

The base of the formation has been but seldom observed. Professor Winchell has recorded one observation upon it. This was in Nicollet County, Minnesota, and he says about two feet of white sandstone with a thin strip of shale overlay the Magnesian limestone below. It frequently retains its arenaceous character to its contact with the underlying rock.* Professor Hall has also noticed the junction, and says that sometimes there is a finely laminated clay with stripes of green,† and the sandstone is often similarly colored. The irregular surface of the Lower Magnesian limestone is frequently the cause of great variations in its thickness, as it fills up hollows and covers ridges which exist there. In Missouri this feature is especially remarkable. Mention is made of one locality where the formation thickens so rapidly as to present the appearance of a dyke cutting off the sandstone both above and below.‡ In another place it forms a bed 240 feet long and sixty feet deep, filling a cavity in the limestone of this extent.||

In 1877, Professor Chamberlin refers to the St. Peter's sandstone in eastern Wisconsin.§ He notes the unequal deposition of the sandstone on the Lower Magnesian limestone, stating that, instead of being of uniform thickness, as has been often asserted, it ranges from a thickness of 212 feet down to a single layer of sand grains. It sometimes varies from 100 feet to zero in the course of a quarter of a mile. Instances are known of its entire disappearance, and the consequent resting of the Trenton limestone on the upper surface of the Lower Magnesian, while in the near vicinity a thickness of from fifty-four to 100 feet has been noted.

THE TOP.

Its junction with the overlying limestone has been more frequently observed. Sometimes the transition is abrupt, but

*Second annual report of the Geological and Natural History Survey of Minnesota, for 1874, 1875, p. 132.

†Report on the Geology of Wisconsin, Vol. I, 1862, p. 29.

‡First and Second Annual Reports of Geological Survey of Missouri, 1855, p. 119.

||Reports on the Geological Survey of Missouri, 1855-1871, 1873, pp. 142-143.

§Geology of Wisconsin. Survey of 1873-1877. Vol. 2, pp. 285-290.

again there occur certain transition beds, of which it is difficult to say whether they should be referred to one or the other formation.

At Seward's quarry, about two miles from Ripon, Wisconsin, the junction between the St. Peter's and the overlying Trenton is well shown. It is here a very friable sandstone, varying in color from yellow to brown. The upper layers, just beneath the limestone, contain concretions or nodules varying in size from half an inch to six inches in diameter. The sand is irregularly stratified. In places it is white, but it is generally more or less stained. The separation between the limestone and the sandstone is distinct. The lower layers of the former contain more or less sand, and are in thin courses one-half to one and one-half inches thick. Above they become heavier, from four to six inches, but do not seem to be fossiliferous. About fifteen feet of the sandstone is exposed. A short distance from this quarry is another exposure of the sandstone about twenty feet high. No limestone capping is present. The sand is often banded with red, while white and brown streaks sometimes alternate. It contains a few concretions near the top, below the junction with the limestone.

At Mitchell's Glen, about four miles from Ripon and a mile from Green Lake, both the Trenton and the St. Peter's occur. The limestone is separated from the sandstone by transition beds about two feet thick. The upper one of these is quite sandy, as is also the lower, but the intermediate stratum, about a foot thick, is a solid, more or less calcareous mass. The St. Peter's proper is more or less friable, and white, yellow or brown in color, more generally one of the latter. The outer surface hardens on exposure, but in places it can be taken out with a spade. At one point in the Glen is a perpendicular fall of about fifty feet, at the bottom of which is a pool of water. The sandstone is here exposed in vertical walls on either side of the Glen to a height of seventy feet, capped by layers of Trenton limestone. The bedding of the sandstone is very irregular, dipping at various angles and in different directions. Numerous large springs of clear, cold water gush out from the sandstone walls. They probably mark the approximate place of junction with the Lower Magnesian. No fossils were observed by the writer.

At another point, also near Ripon, and the evident base of the Trenton, there is an intimate mixture of sandstone and calcareous material. In this occur large specimens of *Orthoceras*, which are of Trenton rather than of St. Peter's age.

At Pomeroy's quarry, near River Falls, Wisconsin, at the top of a high hill, is an exposure of the Trenton limestone in heavy layers, and containing quantities of brachiopods. Beneath this exposure is an outcrop of the St. Peter's, with a vertical height of about fourteen feet. The sand is dazzlingly white, easily disintegrating on exposure. It forms a conspicuous feature in the landscape, the white line of outcrop appearing in numerous places along the face of the hill. No fossils were observed.

On the bluffs east of Prairie du Chien the sandstone occurs above the Lower Magnesian limestone. It is mostly covered, and has an estimated thickness of eighty feet. In the bed of a stream that comes down the hill, several gigantic steps have been formed, each from five to eight feet high and with "treads" two or three feet wide. No fossils were observed.

Professor Chamberlin has also noted passage bed as seen in Rock County, Wisconsin. He says "At several points in Rock County *the passage* of the St. Peter's to the formation above is attended by an alteration of sandstone and calcareous rock. The sandstone just below the calcareous bed is marked with fucoïdal impressions, and the base of the calcareous layer contains abundant *Scolithus* tubes. The calcareous bed is of a greenish-gray cast, containing a large percentage of insoluble, argillo-arenaceous material, in addition to the evident quartzose grains that are more or less freely scattered through portions of it. This has not been observed to attain a thickness of more than four or five feet. The upper portion is usually shaly, and appears at some points to have been eroded before the deposition of the stratum of sandstone above. This latter is thin and mixed with argillaceous material on which sometimes supervenes a thin seam of carbonaceous matter followed by the fossiliferous Trenton limestone. At the most northern point at which the junction was seen, the sand mingles freely with the calcareous layers of the Trenton, for several feet above their base. At most other points the usual abrupt transition was observed."*

*Geol. of Wisconsin, Vol. II, p. 287.

It is also discussed by Professor Swezy, who mentions* the occurrence of the St. Peter's sandstone at Beloit, immediately beneath the Trenton. The author says: "Between the St. Peter's sandstone and the Trenton limestone are eight feet, or perhaps more, of transitional layers; they include, at the bottom, a foot or so of sandstone, more coarse and impure than is usual with the St. Peter's; above this five feet of impure limestone and shale, and at the top two feet more of coarse sandstone." Above this series comes the typical Trenton limestone. In a diagram, presented on page 199, these transitional layers are not referred to either the St. Peter's or the Trenton.

Another excellent exposure, showing transition beds between the Trenton and St. Peter's, occurs at Fountain, Minn. This was first described by Prof. N. H. Winchell, in 1876.† His section is as follows:

SECTION NEAR FOUNTAIN; QUARRY OF JOSEPH TAYLOR.

	FT.
No. 1. Green shale mixed with fragments of limestone that are eminently fossiliferous, seen,	3
No. 2. Limestone, of a bluish-gray color, in beds from four to six inches thick, free from shale, though the layers are sometimes thinly separated by shaly partings,	10
No. 3. Arenaceous and ferruginous shale, alternating horizontally with firmly cemented patches of sandstone, .	2
No. 4. Massive coarse sand; white, except where iron-stained, containing irony quartzite pebbles, and fragile remains of bivalves,	6
No. 5. Green shale, with some arenaceous and calcareous laminations,	3
No. 6. Cemented sandstone, the cement being shale and lime, forming, where the bluff is weathered, the floor of a bench,	1
No. 7. White sand, in beds that are about one foot thick and horizontal,	6
No. 8. A course in the sandstone more firmly cemented, forming another table, but less persistent than No. 6, . . .	1
No. 8 [9]. Massive sandstone, in some places showing an oblique lamination, seen,	6
Total,	38

* On some points in the geology of the region about Beloit. Wisconsin Acad. Sci. Trans., Vol. V, p. 194.

† Fourth Rept. Geol. and Nat. Hist. Sur. Minn., for 1875, 1876, pp. 40-42.

A species of *Lingulepis* is found in No. 4 of the foregoing section. Prof. W. says: "The remains are exceedingly fragile, and as the grains of sand in which they are embraced are feebly cemented together, it is nearly impossible to transport, or even to handle them without their falling to pieces. These fragments, for no entire specimens were obtained, are arranged promiscuously in the coarse sand, and are all confined within three feet of the top of No. 4. They seem to have suffered the attrition and friction incident to coarse sedimentary transportation. They dispel the idea, which has been suggested, of the possible chemical origin of the St. Peter's sandstone, as an oceanic precipitate."

This same locality was visited by the writer in 1889, and the following section was observed:

	FT.
No. 1. Trenton limestone in thin courses,	—
No. 2. Layers of coarse-grained, hard sandstone, formed of grains of rounded quartz, of nearly uniform size, with occasional fragments of Linguloid shells,	1
No. 3. Loose sand, with yellow and brown streaks and greenish spots,	6
No. 4. Greenish shale and sandstone, mostly shale, . .	5
The upper portion of this bed is a white sandstone, formed of rounded grains of quartz, cemented by carbonate of lime, and containing fragments of fossils. The interstices of the sandstone are filled with fine particles of sand. Below this the shale is a mixture of clay, lime, and sand, the former green, the latter white, and formed of rounded quartz grains. The green shale contains what appear to be worm burrows (<i>Planolites</i>), and fragments of <i>Lingulepis morsensis</i> Winchell.	
No. 5. White sandstone of St. Peter's, covered, —	
Total observed,	12

About half a mile further down the railroad another exposure occurs. Here the typical St. Peter's sandstone is well exposed, and it is overlaid by the same succession of shale, loose sand, hard sandstone and limestone, as that in the previous section. In the upper portion of the shale are certain iron-stained layers, in which brachiopods of the genus *Orthis* are found. These are also seen in the sandstone, together with fragments and impressions of *Lingulepis morsensis*.

In the twelve feet of sand and shale given in the above section, we have transition beds between the true Trenton limestone and the typical St. Peter's sandstone below. It would appear that after the deposition of the white sandstone there came a period of muddy seas, during which the greenish shales were laid down. Then followed a period of elevation to near the surface, when the loose sand and the harder beds below were deposited. The latter were probably cemented together by lime from the layers of limestone above, which were in their turn laid down in a deepening sea, that soon swarmed with life.

In a late paper by Messrs. Hall and Sardeson* a similar conclusion is reached. These authors say that they nowhere found in Minnesota any indication of an unconformity between the Trenton and St. Peter's. "The transition zone of a green shaly calcareous sandstone shows the steady oncoming of that Lower Silurian sea which, if it did not submerge the whole Northwest, at least extended so far that the dry land was reduced to islands, or narrow peninsular stretches of very uncertain connection with a mainland lying somewhere."

STRATIGRAPHIC POSITION.

The position of the formation in the stratigraphical column is unequivocal. It lies between the Lower Magnesian limestone and the Trenton limestone, but its limited area in the country, and its practical isolation from eastern localities, renders its correlation with formations elsewhere a matter of difficulty. In addition to this the almost total absence of fossils adds to the perplexity, as it is by means of the organic forms that rocks are most accurately correlated. The only point where direct stratigraphic continuity with any eastern North American formation can be looked for is on the Canadian side of the Sault Ste. Marie. Its presence here is shown on the geological map of Canada by Hall and Logan,† though it is present to only a limited extent. It does not occur again, in outcrop at least, until the Ottawa River is reached.

* Bull. Geol. Soc. America, Vol. III, p. 355.

† Atlas accompanying Geology of Canada from commencement to 1863. 1865.

some 350 miles to the eastward. Even in Canada and the eastern States, where it is known as the Chazy, it occupies scattered patches, which are limited in area. On the map referred to above, the sandstone on the south shore of Lake Superior, and the outcrops of St. Peter's in Wisconsin and Minnesota, are colored as Chazy; and in another map in the same atlas, showing the distribution of the Huronian rocks, by Sir W. E. Logan, the distribution of the sandstone is given in more detail, and it is designated in the legend as "Chazy (St. Peter's Sandstone)."

The reference of the St. Peter's to the horizon of the Chazy has been made by various writers, solely, it would appear, upon stratigraphic evidence. Hall, in 1863,* considered it as the equivalent of the Chazy. He says: "So long since as 1845, I had myself observed that the sandstones of the St. Mary's River come out from beneath the Black River and Birdseye limestones; but the Calciferous sandstone was nowhere visible in the immediate neighborhood. The later and more complete investigations of the Canada Geological Survey have proved the absence of the Calciferous sandstone, and of the Potsdam sandstone, on the north shore of Lake Huron; and, also, that this sandstone of St. Mary's River (which is now regarded as identical with that of the south shore of Lake Superior), rises from beneath the Black River and Birdseye limestone, and there is no evidence of the Calciferous sandstone in that region. It is the opinion of Sir William Logan, that this sandstone represents the Upper sandstone, or fills the place of the Chazy formation in the East, the limestone being absent; and that it is this arenaceous deposit, greatly augmented, which gives the sandstone formation of the south shore of Lake Superior (Geology of Canada, 1863, pp. 83-86)."

After giving the sequence of the formations as found in the Mississippi valley, as Buff limestone-Birdseye and Black River; St. Peter's sandstone; Lower Magnesian limestone, he says: "In assigning a position to the sandstone of the south shore of Lake Superior, to the south and east of Keweenaw point, from the evidence before us, and in the absence of any fossils which may aid the decision, we are

*Sixteenth Ann. Rept. N. Y. State Cab. Nat. Hist., pp. 214-215.

forced to conclude that this formation is a greatly augmented development of the St. Peter's sandstone; or, that the Lower Magnesian limestone ("Calciferous sandrock") has thinned out, so as to leave the St. Peter's sandstone and the Potsdam below (as developed in the Mississippi valley) to go on as one mass to the northward."

"It is scarcely possible to suppose that the lower sandstone of the upper Mississippi Valley has not, at some time or in some form extended as far as Lake Superior; but it is far from being proved that the sandstone now so largely developed on the south shore is that sandstone, as we have shown. If this sandstone consist of both that above and that below the Calciferous, or of the St. Peter's and the Potsdam proper, then at some point we should expect to find a change of character, or nonconformity between the beds, to indicate the lapse of time in the deposition of the Lower Magnesian limestone of more southern localities; and this view is sustained by the observed want of conformity between the sandstone and Magnesian limestone near Dead River just cited."*

The question is here left in an unsatisfactory condition; but if the later conclusions,† that the Lake Superior sandstones are Potsdam or pre-Potsdam in age be sustained, it is probable that the St. Peter's formation will be confined to a narrow strip through the northern peninsula from the Menoninee to St. Mary's River.

Hall asserted the same again in 1869,‡ as did also Logan|| in the map of Canada in 1865.

In referring to the sandstone east of Keweenaw Point, sometimes called the Eastern sandstone, Dr. Alex. Winchell§ considered it as the probable equivalent of the Calciferous and Chazy formations of New York. He says, in regard to the Lake Superior sandstone as a whole: "The portion west of the Point is thought by some to be of the same age [Calciferous and Chazy], while others regard it as the equiva-

*Ibid, pp. 215-216.

†Irving, R. D.: Copper-bearing rocks of Lake Superior. Monographs U. S. Geological Survey, Vol. V, 1883.

‡Am. Phil. Soc. Trans., new ser., Vol. XIII, p. 329.

||Atlas accompanying the Geology of Canada from the commencement to 1863. 1865.

§Sketches of Topography, Climate and Geology of Michigan. Walling's Atlas of Michigan, 1873, p. 46.

lent of the sandstones in Wisconsin and Minnesota, which are generally ranged in the horizon of the Potsdam of New York. As the uplift of Keweenaw Point has tilted the sandstones on the west, while those on the east have retained their horizontality, there is reason for supposing that the eastern strata are of more recent origin. It may, nevertheless, be true that the sandstones on both sides of the Point are of the same age, though those on the eastern side were not permanently tilted by the convulsion which upheaved the others. As we find apparently superincumbent strata, which answer to the Calcareous, we shall continue to parallelize the Lake Superior sandstone, presumptively, with the Potsdam."

Dr. Rominger, in 1873,[†] also considers the Chazy and Calcareous under one head. In his description he says: "Below the well-characterized Trenton strata, and reposing on the Lake Superior sandstones, we find over the whole extent of the Peninsula a series of calcareous or arenaceo-calcareous beds which hold the place of the Chazy limestone and the calciferous formation of the Eastern States. We can not distinguish two different formations with different faunas in the West, where all the fossils ever found are three or four species of shells, and those generally in imperfect condition. But we can see a plainly expressed typical similarity between the fossils of the eastern and western localities. Also the lithological characters of the compared rocks are in perfect general correspondence, so that we can safely consider our western strata as the equivalents of the two named groups of the New York system. The greatest observed thickness of the formation within the district is near 100 feet, but usually it is not found in so large a development." Worthen, in 1866,[‡] considered the St. Peter's to form the upper portion of the Calcareous series of New York, while in 1874, Broadhead|| makes the Saccharoidal sandstone equal to the St. Peter's and also to the Calcareous.

In 1883 Prof. Chamberlin§ gave a résumé of the knowledge of the formation. It is stated to repose on the billowy sur-

*Ibid, pp. 43-44.

†Michigan Geological Survey. Palæozoic Rocks, 1873, p. 71.

‡Geological Survey of Illinois, Vol. I, 1866, p. 149.

||Report of the Geological Survey of Missouri; field work, 1873-1874; 1874, chart oppo. p. 18, and p. 29.

§Geology of Wisconsin, Survey of 1873-1879, Vol. I, 1883, pp. 145-150.

face of the Lower Magnesian, and to be an almost pure quartzose sandstone. The greatest thickness observed was 212 feet, but its average is hardly over eighty. Traces of life are rare. The method of formation is considered due to mechanical action, rather than to chemical solution. In discussing its history it is stated that the sand was probably derived from the Archean nucleus or the Potsdam sandstone toward the north, which was then exposed above the surface, or at least subject to the mechanical action of the waves. The distribution is given, the Saccharoidal sandstone in Missouri and the Chazy limestone of New York being considered its equivalents. He says: "We have felt somewhat inclined to refer its main deposition to the closing Calciferous or early Quebec, and to suppose that it was rewrought by the advancing sea in the Chazy or early Trenton epoch, the remainder of the interval between the Calciferous and the Trenton being unrepresented in our series, because the water had retired."*

As known in New York, the Chazy formation is essentially a limestone, and therefore differs greatly in lithological features from the St. Peter's. But in Canada the limestone is associated with sandstones and shales. At Greenville the calcareous strata are succeeded by about fifty feet of whitish sandstone, in beds from two or three to twelve inches, interstratified with bands of green shale, holding great numbers of fucoids.† A sandstone, in beds of from four to twelve inches thick, interstratified with green arenaceous shales is found resting on the Laurentian, and immediately underlying the Trenton. This is found near the mouth of the Coldwater on Lake Huron.‡

The beds of sandstone here mentioned form, however, only a small portion of the formation, while in the west the calcareous feature is almost entirely absent. This difference in lithological features, and the scarcity of fossils combined, has made it difficult to say positively, but the facts all point to the conclusion that in the St. Peter's sandstone we have the western equivalent of the Chazy limestone of the New York system. The correlation rests almost entirely upon the stratigraphic position.

*Ibid, p. 150.

†Geology of Canada, from the commencement to 1863. 1863, pp. 123-124.

‡Ibid, p. 192.

FOSSILS.

The organic remains found in the St. Peter's are but few. The following list is believed to include all that have been noticed as occurring.

BRACHIOPODA.

Lingulepis morsensis Winchell. Prof. N. H. Winchell, in 1876, described this species as follows: "Shell conical or elongate-conical, with anterior angles rounded; depressed; the apical angle not seen perfect; the front margin gently convex; sides nearly straight, but converging at an angle of about 26 degrees; greatest width is near the front, and at a distance from the anterior margin of one third the greatest width. The surface is smooth and shining, marked with very fine concentric striæ, visible especially in the anterior portion, and with more distant, dim undulations of growth. Entire length of the larger specimen seen about .85 inch; width, .52 inch; length of the smaller, .78 inch; width, .45 inch. Color of the shell light brown, with spots of brown. The smaller specimen has flattened, or slightly concave margins, for nearly two-thirds the length from the apex. The species in general contour resembles *Lingulepis briseis*, of Billings (Palæozoic Fossils, Vol. I, p. 48), but differs from it in not having its sides parallel."*

This species is found at Fountain, Minnesota, in a sandy shale, in transition beds between the Trenton and the typical St. Peter's, and it is really questionable if it belong to the latter period. It has, however, been placed there by Winchell, and is therefore inserted here.

Orthis sp. cf. *testudinaria* Dalman. A species of *Orthis* resembling in size and marking *O. testudinaria*, occurs in the sandstone and shale beds at Fountain, Minnesota, in association with *Lingulepis morsensis*. A similar form is found in the Trenton, which overlies the St. Peter's at Ripon, Wisconsin.

*Fourth Annual Report of the Geological and Natural History Survey of Minnesota for 1875. 1876, p. 41.

GASTEROPODA.

Specimens of the genus *Murchisonia* are referred to by Meek as occurring in Montean County, Missouri.* Crinoid columns were also found associated.

Fragments of the internal casts of *Straparollus* and *Chemnitzia* were stated by Shumard to be found in the sandstone in Ozark County, Missouri.† They were too imperfect for accurate determination.

Maclurea (?). This is recorded by F. W. Sardeson‡ as occurring in the St. Peter's formation, near St. Paul, Minnesota, together with the species mentioned below. From the uncertainty felt in the identifications, it seems evident that the fossils are not in a very good state of preservation. Mr. Sardeson states that they occur about fifty feet below the top of the formation, and that "they are remarkably like species found in the lower part of the Trenton shales and in the Trenton limestone, which here rests conformably on the St. Peter sandstone."

Murchisonia gracilis Hall. *Murchisonia* (?) *tricarinata* (?) Hall.

LAMELLIBRANCHIATA.

Cypricardites rectirostris Hall. *Cypricardites*, 2 sp. undeter.
Modiolopsis? (Mentioned by Sardeson.)

ANNELIDA.

Arenicolites; *Scolithus* sp. A species of *Arenicolites* is referred to by Winchell|| as occurring in the sandstone at Faribault, in Rice County, Minnesota. He says: "The sandstone here is pitted with circular holes, such as have

*First and Second Annual Reports of Geological Survey of Missouri, Part II, 1855, p. 106. There is considerable doubt in regard to the exact position of all the fossils here recorded from Missouri. As already noted the Saccharoidal sandstone in which they are stated to occur, is referred by Nason to the Cambrian.

†Reports of the Geological Survey of Missouri, 1855-1871. 1873, p. 192.

‡Fossils in the St. Peter Sandstone. Bull. Minn. Acad. Nat. Sci., Vol. III, p. 318.

||Geological Survey of Minnesota. Volume I of the final report. 1884, pp. 656-657.

been seen in a number of places in the State.* They are brought to view distinctly in the weathered and hardened surfaces, since the homogeneous sand on fresh fractures seems to constitute the entire rock, and no trace of these fossils is visible to the eye. They appear at this place on a lower bench, where the rock is hardened and reddened. They always run perpendicular, and can be traced to a depth of two and a half feet by the little furrows they cause on the face of the rock after the breaking and sliding down of masses of the bluff. This structure was first seen in this sandrock at the base of Dayton's bluff, at St. Paul, and was ascribed to Cretaceous lithodomous shells, but it is more likely to be due to some marine vegetable, or to worm-burrowing, of Cambrian age. By examining areas that have suffered different degrees of exposure, there can be traced a connection from the actually empty porous openings, through different degrees of exposure and induration, including a simple annular spottedness, to an innate internal structure in the mass of the rock itself. It would be the same as if a multitude of horse-tail rushes, or others, were growing in the bottom of the sea when the sand was accumulating, and became gradually buried under the sand, and then were imprisoned and fossilized, their presence only being evinced now by the cementation of the sand-grains about their exterior, or by a looseness of the same in their interior, thus not only forming a rude cast of each stem within the rock, but also providing for the more rapid erosion and removal of the grains that may have reached within their cases. The spots are only seen on upper surfaces, and if they be not due to imprisoned rushes or stems of some sort, or to worm-burrowing, they are at present inexplicable. They are generally from an eighth to a quarter of an inch in diameter."

This species the present writer has proposed to call *Scolithus minnesotensis*.†

Similar tubes are noticed as occurring at Waterloo and Beloit, Wisconsin.‡ In Illinois, in LaSalle County,|| a peculiar feature of the sandstone is noticed. It is stated to contain

* "They are conspicuous at Castle Rock, in Dakota County."

† Bull. Geol. Soc. America, Vol. III, 1891, p. 41.

‡ Chamberlin, T. C. Geology of Wisconsin, Survey of 1873-77, Vol. II, 1877, p. 288; also, Vol. I, 1883, p. 147.

|| Geological Survey of Illinois, Vol. III, 1868, p. 280.

an infinite number of minute vertical holes, about the size of knitting needles. These are, perhaps, *Scolithus* tubes. In Missouri, there is found a sandstone formed of columns perpendicular to the plane of deposit,* and these may also be *Scolithus* tubes.

Planolites sp.—A species of *Planolites* was found by the writer in 1889 at Fountain, Minnesota, in strata referred to the St. Peter's. It is associated with *Lingulepis morsensis* and *Orthis* sp., already noted, but it has not been referred to any species.

CEPHALOPODA.

Orthoceras.—Fragments of *Orthoceras*, some of large size, are noted as occurring in this sandstone in Missouri.† One locality is in Maries County,‡ the specimen stated to be five and one-half inches in diameter, while other specimens thirty inches in diameter and ten feet long are found near the line between Gasconade and Franklin Counties. In the roof of a cave near Marthasville, circular rings, supposed to be cross sections of *Orthoceras*, are noted.|| It is possible that these specimens really belong to the overlying Trenton. The writer has collected large specimens of the genus from the Trenton at Ripon, Wisconsin, in strata which were more arenaceous than calcareous, and which might readily have been referred to as a sandstone.

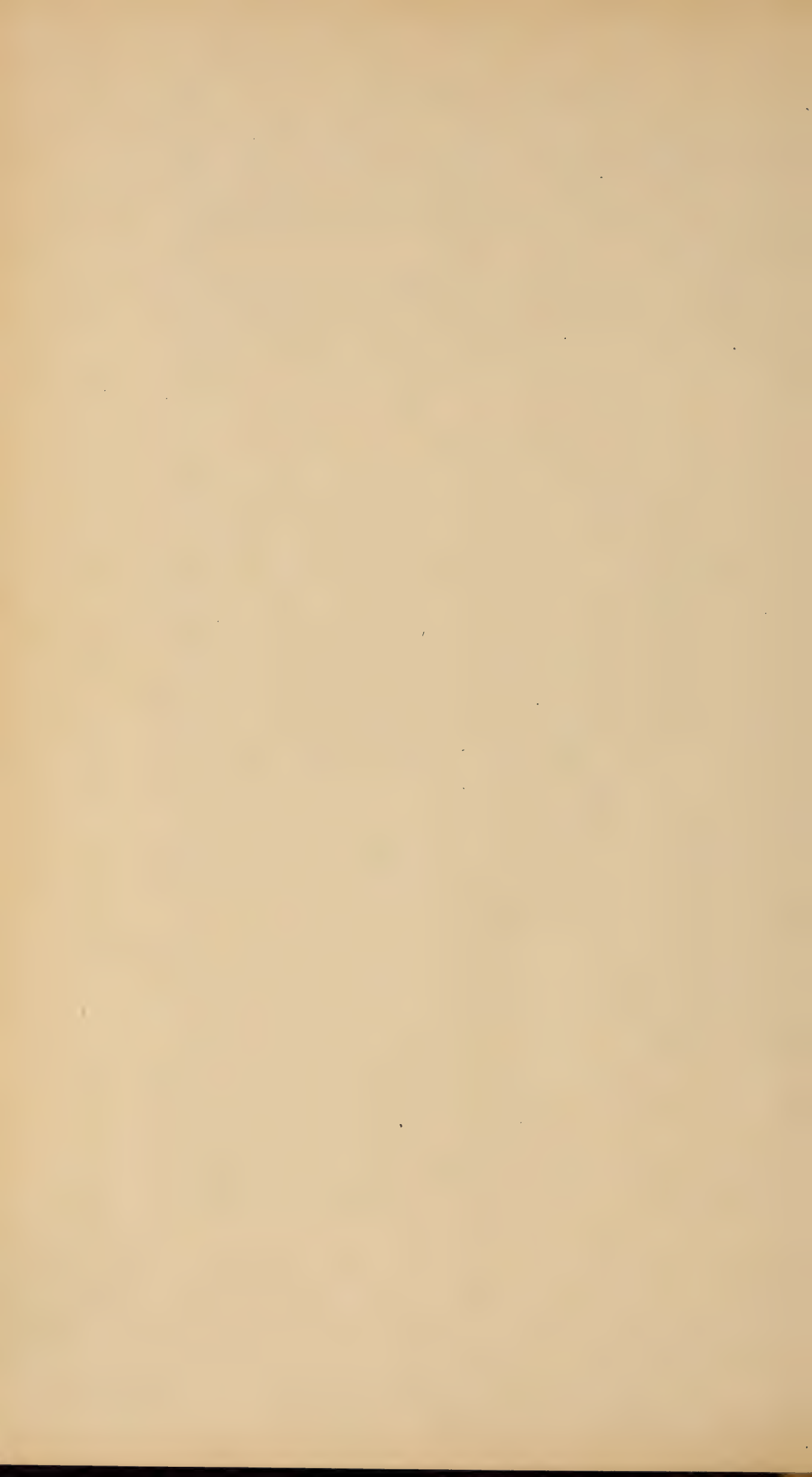
The smallness of the number of species found in the sandstone is thus seen. Their occasional presence, however, may be considered a proof that the formation is of mechanical origin and not a chemical precipitate.

* Reports on the Geological Survey of Missouri, 1855-1871. 1873, p. 55.

† Swallow, G. C. Explanations of the Geological Map of Missouri, etc. Am. Asso. Adv. Sci. Proc., Vol. XI, Part 2, 1858, p. 17.

‡ Reports of Geological Survey of Missouri, 1855-1871. 1873, p. 10.

|| Ibid, p. 55.



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NO. 3.

DESCRIPTION OF SOME CINCINNATI FOSSILS.

BY S. A. MILLER AND C. L. FABER.

GOMPHOCERAS INDIANENSE n. sp.

Plate 7, Fig. 3, body chamber and ten septa; Fig. 5, outline of a transverse section; Fig. 4, outline of the tenth septum and position of siphuncle.

Shell medium or a little above medium size. Transverse section ovate. Ventral or narrow side of the ovate outline nearly straight, while the opposite or dorsal side is strongly arched from the apex to the mouth. Body chamber forming nearly half the length of the shell; the specimen illustrated has part of the tenth air chamber, and another specimen has part of the eleventh air chamber preserved, and apparently it approximates close to the apex. Probably, if complete, these specimens would not have more than thirteen or fourteen air chambers. Septa moderately concave, the concavity not amounting to the depth of an air chamber, and almost equally distant from each other, from the apex to the body chamber. The increase in the diameter of the shell is not followed with a corresponding increase in the distance of the septa from each other, or in the length of the air chambers. The sutures curve forward over the dorsal or convex side of

the shell. The greatest transverse diameter is in the lower half of the body chamber. The siphuncle is marginal on the straight or ventral side, and abruptly expands in the cavities of the short air chambers to two and a half or three times its diameter at the septa. The aperture is unknown.

The external shell is thin, transversely wrinkled and smooth. The surface being smooth, the transverse wrinkles do not appear as lamellose lines of growth, nevertheless the wrinkles may mark stages of growth in the shell, though they do not conform to the septa or sutures.

This species does not resemble *Gomphoceras eos* from rocks of about the same geological age. *Gomphoceras eos* is longitudinally ovoid, but not transversely ovoid. This species is not longitudinally ovoid, for the lateral sides are flattened, the ventral side nearly straight or slightly convex and the dorsal side convex, but transversely it is more or less ovoid. *Gomphoceras eos* has proportionally a much shorter and more robust body chamber, more numerous air chambers and more arcuate septa, and the siphuncle is eccentric in the middle of the greater diameter of the shell. We have a good specimen of *Gomphoceras eos*, having eight body chambers, and will give some measurements for comparison. The body chamber is $1\frac{8.5}{100}$ inches long; $2\frac{6.0}{100}$ inches in diameter dorso-ventrally or through the siphuncle; and $3\frac{2.0}{100}$ inches in diameter laterally; the length of the eight air chambers is $1\frac{6.5}{100}$ inches, making the total length of the entire specimen $3\frac{5.0}{100}$ inches; the lateral diameter of the last or eighth air chamber is $2\frac{1.0}{100}$ inches, and dorso-ventrally nearly 2 inches, though it is broken on the siphuncular side so the latter measurement is not accurate. The specimen illustrated has a body chamber $1\frac{8.0}{100}$ inches long; $2\frac{8.0}{100}$ inches in diameter dorso-ventrally; and only 2 inches in diameter laterally; the length of the two specimens does not differ very much; but the eighth air chamber in the specimen illustrated has a dorso-ventral diameter of $1\frac{8.0}{100}$ inches and a lateral diameter of only $1\frac{4.0}{100}$ inches. The outer shell and aperture of *Gomphoceras eos* are unknown, but our cast shows a deep notch at the ventral side of the aperture, which indicates that the species here described is not congeneric with it.

Mr. Faber collected three specimens of this species, one of which is illustrated, in the upper part of the Hudson River Group, near Versailles, Indiana, and Prof. Hubbard and Mr. J. F. Hammell collected a number of specimens in the same range, associated with *Cryptocerina madisonensis*, near Madison, Indiana.

ORTHOCERAS LUDLOWENSE n. sp.

Plate 7, Fig. 1, lateral view of ten chambers, also showing the arching of the chambers; Fig. 2, an end view, showing the eccentric position of the siphuncle.

This species is the largest known to the authors that has been found in the Hudson River Group, about Cincinnati. The shell is very large, robust, straight and gradually and regularly enlarges from the apex to the mouth of the chamber of habitation. The septa are distant and highly arched. A transverse section of any of our specimens is subelliptical, but it appears as if this might be due more or less to pressure. Possibly a transverse section of a perfectly preserved specimen would be circular, though our specimens do not indicate such to be the case; we think all specimens will be found somewhat flattened on the side near the siphuncle and probably on the side opposite thereto, as indicated by our specimens.

The chamber of habitation, in one of our specimens, is eight and one-half inches in length and is incomplete; its greater diameter, at the mouth, is four inches, and the greater diameter, at the air chambers, two of which are attached, is three and one-half inches. There are ten air chambers illustrated, but the specimen is broken, and we have four more air chambers that belong to the smaller end. The length of the fourteen air chambers is ten and a half inches, the greater diameter, at the larger end, is two and four-tenths inches, and the greater diameter, at the smaller end, is one and forty-five hundredths inches. These measurements indicate that the total length of a specimen, four inches in diameter, at the mouth, would be about three feet and a half.

The smaller diameter of a specimen is a little more than the length of two air chambers, and the greater diameter is a

little less than the length of three air chambers in any part of our specimens, except, of course, adjoining the body chamber, where, as in all species of *Orthoceras*, the air chambers are not completely developed in length. However, the second air chamber from the body chamber, in our specimen, has attained nearly its entire length, and from appearances the third chamber was fully developed. The siphuncle is eccentric and much expanded within the air chambers. It would be regarded as a rather large and strongly beaded siphuncle. The septa are thin and on the surface transverse, and every thing indicates a thin external shell. The surface markings and initial extremity are unknown.

This species is distinguished by its great size, great length, large body chamber, distant and highly convex septa, and large, beaded siphuncle. It has, apparently, no near affinity with any described species from rocks of the same age. When compared with *Orthoceras amplicameratum*, from the Trenton Group, of New York, the shell is larger, more rapidly tapering, septa more distant, and siphuncle more strongly beaded. It would throw no light on it to compare it with *Orthoceras medullare*, from the Niagara Group, of Illinois, for the surface of that species is marked with strong, sharp, subequal longitudinal striæ, which are cancellated by fine transverse striæ, which our species could not have possessed.

This species occurs in the lower part of the Hudson River Group, at and about Cincinnati. It has been found in the banks of the Ohio opposite Cincinnati, in Ludlow, and at the lower part of Covington, Ky. The specimens illustrated and described belong to the collections of the authors.

ORTHOCERAS ALBERSI S. A. Miller.

Plate 8, Fig. 1, lateral view, showing part of the shell with its longitudinal furrows; Fig. 2, part of another specimen with the outer shell removed; Fig. 3, a single chamber, showing the convexity of the septa; Fig. 4, an end view, showing the eccentric position of the siphuncle.

Shell straight, rather below medium size, and gradually and rapidly enlarging from the apex to the body chamber. The

diameter increases to twice the size, or is doubled, in the distance of two inches. Transverse section circular, though toward the body chamber the shell may be depressed and a transverse section slightly elliptical. Septa moderately arched and distant from one-fourth to two-ninths of the diameter of the shell. Body chamber unknown. Outer shell rather thick and longitudinally lined. The lines are fine, and increase in number with the enlargement of the shell, by implantation, and they are disposed to a fascicular arrangement that gives the shell the appearance of being longitudinally furrowed. Siphuncle eccentric, a little nearer the center than the margin, round and small where it pierces the septa, and only moderately expanding within the chambers.

This species is only known from the lower part of the Hudson River Group, where it is found associated with *Orthoceras transversum*, though it is a much rarer shell. The specimens illustrated are from the collection of the author. The specific name is in honor of August Albers, who made the drawing and is a well-known and active collector.

SPHENOLIUM CUNEIFORME S. A. Miller.

Plate 8, Fig. 5, part of the right valve of the shell; Fig. 6, the beak and part of the hinge line showing the ligamental furrow.

More than twenty years ago the author found a very complete and perfect cast of this species. After the lapse of about ten years, no other specimens having been found by any one, he concluded to call general attention to it, by giving it a specific name. He was not willing to found a genus on a single cast, especially when it seemed to be related, in some respects, to a defined genus, and, therefore, he called it *Orthodesma cuneiforme*. Nearly ten years more transpired, when Mr. Faber having found casts belonging to two distinct species in the same genus, the author felt justified in proposing a generic name, and, accordingly, in 1889, he founded the genus *Sphenolium*, with *Sphenolium cuneiforme* as the type. This history is related for the purpose of showing how rare

fossils are at one time and how common they may afterward become. The present year, notwithstanding the place had been hunted over many times by the authors, Mr. Faber walked over the exposure at which the original *Sphenolium cuneiforme* was found, and picked up another cast, nearly as good as the original, and also part of the valves of another specimen, one of the valves of which is illustrated with this article, and which also shows part of the hinge line that is illustrated. And to nearly complete our knowledge of the shell of this genus Mr. Miller, on a trip to Richmond, Ind., the present Summer, obtained a specimen of *Sphenolium richmondense*, preserving almost the entire shell in a rare state of preservation. We propose now to describe the shells of both species.

The shell of *Sphenolium cuneiforme* is marked with strong concentric lines of growth, that, on account of the thickness of the shell, do not seem to have made any impression on the casts. The beaks are acute, incurved over the external hinge ligament and approximate. The antero-basal part of the shell extends a little further forward than the beaks. The umbones, though high, are somewhat flattened, and there is an undefined shallow depression toward the basal margin that separates the well-defined posterior umbonal slope from the imperfectly-marked anterior umbonal ridge. The cardinal line is directed, at a high angle, from the basal margin; the shell at the hinge is very thick, and each valve bears a wide, concave furrow, with longitudinal ligamental lines, for the attachment of a strong external ligament. Our specimen shows no evidence of teeth or sockets of any kind.

The shell of *Sphenolium richmondense* is proportionally much the shorter, and is marked with much finer concentric lines of growth, which are almost obsolete over the umbones, and the shell being thick, they have left no impression on the casts. The beaks are acute, incurved over the strong external ligament, and approximate at the extreme anterior end of the shell. The umbones are higher than in *Sphenolium cuneiforme*, and the thickness of the shell, through the umbonal region, is greater than the height from the basal line to the cardinal margin. The greater thickness of the shell is between one-third and one-half the entire length from the anterior end.

The umbonal sulcus is not well defined, but it seems to straighten the basal margin. The cardinal line is directed at a high angle from the basal margin; the shell is thick, and the valves are held together by a very strong external ligament that is remarkably well preserved in our specimen. There was no gaping of the shell at either end.

Sphenolium and *Orthodesma* belong to the same family of shells, and, as at present advised, they will fall into the same family with *Orthonota*, and, therefore, belong to the *Orthonotidae*.

ORTHODESMA CYMBULA n. sp.

Plate 8, Fig. 7, right valve of a nearly complete cast; Fig. 8, left valve of another specimen; Fig. 9, cardinal view of the same, the posterior end is broken, but there is no evidence that the shell was gaping.

Shell elongate, about three and a half times as long as wide; thickness nearly equal to the width, which gives to the shell a subcylindrical aspect, in the middle part, or taken as a whole, including the cuneiform ends, the general form might be called subfusiform. Beaks small, pointed, situated about one-ninth or one-tenth of the entire length of the shell from the anterior end, incurved and approximate. Cardinal line straight posterior to the beaks, and less than one-half of the length of the shell; anterior end rapidly contracted forward of the beaks, the point of greatest length being directed a little downward below a straight continuation of the cardinal line. Anterior end acute, from which the shell rapidly rounds into the base below. Posterior part gradually recedes from the termination of the cardinal line to near the posterior end, where it is obliquely truncated and terminates in the sharply-rounded postero-basal margin. Posterior umbonal ridge prominent, subangular anteriorly, but becoming more rounded posteriorly, and extending to the postero-basal end of the shell. Anterior umbonal ridge subangular near the beak, where it is well defined, but gradually rounding and spreading below, it becomes obsolete in the basal margin. Body of the valve sharply sinuate on the umbo, between the anterior and

posterior umbonal ridges, which sinus is directed backward, and gradually widening, it terminates in a broad contraction of the basal margin a little anterior to the middle of the shell.

Surface of the valves marked by concentric lines of growth, which appear as deep undulations at the anterior end of the shell. There is some evidence of fine radiating lines on the posterior umbonal slopes, but they are too indefinite on our specimens to be shown in the illustrations. Our specimens are casts, none of the shell itself is preserved. There was no gaping of the shell at either end.

This species in some respects might be compared with *Orthodesma rectum*, the type of the genus, but it is much more closely related to *Orthodesma mickelboroughi*. It is true, that the long subfusiform shape at once distinguishes it from *O. mickelboroughi*, but that is nearly all the difference there is between them. Suppose you could take hold of the postero-basal angle of an *O. mickelboroughi* and draw the shell out, by taking up the basal margin, without lengthening the cardinal line, or seriously disturbing it anterior to the beaks, until the shell is increased one-half in length, you would produce a shell very much like the species here described. There seems to be no substantial difference between the species, except in the relative proportions of the shells. So impressed were we with this fact, that we laid Whitfield's definition of *O. mickelboroughi* before us, and followed it when writing the description of this species, so that any one can the more readily make the comparison. Had *O. mickelboroughi* to stand alone on the type specimen, there might be a suspicion that it was founded on an abnormal specimen, but such is not the case, for one of the authors has two specimens, one of which is better than the type, and proves that the species was founded on a normal cast. There was no gaping at either end of *O. mickelboroughi*. When this species is compared with *O. rectum*, the shorter hinge line, tapering posterior end and surface undulations will readily distinguish it, but such differences are not of generic importance, nor higher than ordinary specific differences among the casts of the shells of Lamellibranchiata.

In a recent publication, by the Geological Survey of Minnesota, a new generic name, spelled *Rhytimya*, has been pro-

posed to include such species as *Orthodesma byrnesi*, *Orthodesma mickelboroughi* and *Sedgwickia* (?) *lunulata*. Whitfield, when he described *Orthodesma mickelboroughi* and *Sedgwickia* (?) *lunulata* never, for a moment, suspicioned that they could be congeneric. *Sedgwickia* (?) *lunulata* is nearly equilateral, and has somewhat the form of two dorsally-rounded Bellerophons, with their ventral sides and mouths pressed together. The authors have good specimens of the species, and can not imagine how any one, with any knowledge whatever of shells, could think of classing *Sedgwickia* (?) *lunulata* with *Orthodesma mickelboroughi* and *Orthodesma byrnesi*. As we have shown above, the species under consideration is most clearly an *Orthodesma*, and for the same reasons *O. mickelboroughi* is a true *Orthodesma*, and we would as soon think of proposing a new generic name for the type of the genus *Orthodesma* as for *O. mickelboroughi*. Not a shadow of a reason is suggested why *Orthodesma byrnesi* should be removed from *Orthodesma*, and we have not discovered any reason for so doing. From the present state of learning in regard to these fossils, it would seem that *Rhytimya* may be relegated to synonymy.

The species above described is not very uncommon in the upper part of the Hudson River Group, in Warren County, Ohio, and the specimens illustrated are in the collections belonging to the authors.

ORTHODESMA SCAPHULA n. sp.

Plate 8, Fig. 10, view of the right valve; Fig. 11, cardinal view of the same specimen.

This is a small species, much below the average size, and most nearly related to *Orthodesma cymbula* above described. Shell elongate, a little more than twice as long as wide, and about one half wider than thick. Subelliptical in longitudinal outline, though most cuneate posteriorly. Beaks small, obtuse, situated about one-sixth or one-seventh of the entire length of the shell from the anterior end and approximate. Cardinal line straight posterior to the beaks for about one-

third the entire length of the shell, and then the shell recedes regularly until it terminates at the sharply-rounded postero-basal end. Anterior end rapidly contracted forward of the beaks, the point of greatest length being directed a little downward below a straight continuation of the cardinal line: from the obtuse anterior point the shell is rounded into the basal margin. Body of each valve marked by a shallow sinus directed downward and backward from the umbo, and gradually widens to the basal margin, which it serves to straighten in the middle part. Posterior umbonal slope broadly rounded and extending to the postero-basal margin. Anterior umbonal ridge broadly rounded and indistinctly defined.

Surface of the valves marked by concentric lines of growth and stronger undulations, which are most conspicuous at the anterior end and below the posterior umbonal ridge. There are also radiating lines on the posterior umbonal ridge and some evidence of pustules. Our specimens are casts; none of the shell is preserved. There was no gaping of the shell at either end.

Found in the middle part of the Hudson River Group, on the hills about Cincinnati, Ohio, and now in the collection of Mr. Faber.

ORTHODESMA ASHMANI n. sp.

Plate 8, Fig. 12, right valve; Fig. 13, left valve; Fig. 14, left valve of a smaller specimen.

Shell moderately elongate or proportionately shorter and thinner than is usual in this genus, and having somewhat the form of *Orthodesma byrnesi*. Cardinal and basal margins subparallel, and ends rounded so as to give a longitudinal sub-elliptical outline to the shell. Length, from two and a quarter to two and a half times the width; valves depressed, convex, giving the shell a thickness of less than half the width. Beaks small, obtusely pointed, incurved, approximate, and situated a little more than one-fourth of the length of the shell from the anterior end. Cardinal line straight, posterior to the beaks for more than half the entire length of the shell, from which point the shell is obliquely truncated and rounded

to the postero-basal extremity. Anterior end contracted forward of the beaks, subacutely pointed and then broadly rounded into the basal margin. Body of each valve marked by a shallow and ill-defined sinus that is directed downward and backward from the umbo, and gradually widens to the basal margin, which it slightly contracts in the middle part. Posterior umbonal ridge low, subangular, but becoming more rounded, and less defined toward the postero-basal end of the shell. Antero-umbonal ridge rounded and indistinctly defined. Surface of the valves marked by concentric lines of growth, and also by strong undulations from the subangular part of the posterior umbonal ridge to the front, the undulations being deepest at the anterior end of the shell. There are also well-defined radiating lines on the posterior umbonal ridge, and the whole surface is covered with pustules that suggest the probability that they indicate the presence of spines, as in *Orthodesma byrnesi*. The shell was preserved in *Orthodesma byrnesi* and also the matrix, in which the specimen was embedded, and the spines were well preserved, though so fine that it required a magnifier for their examination. They reminded one of the spines on some species of *Productus*. This species is founded on numerous casts, but no part of the shell is preserved. There was no gaping of the shell at either end.

Found in the lower part of the Hudson River Group, at Cincinnati and Covington, and now in the collection of Mr. Faber. The specific name is in honor of Mr. George Ashman, a well-known Cincinnati collector.

TECHNOPHORUS CINCINNATIENSIS n. sp.

Plate 8, Fig. 15, left valve, magnified four diameters; Fig. 16, same, natural size.

Shell very small, somewhat trapezoidal in outline, a little more than twice as long as wide, and a little wider than thick. Cardinal lines straight, anterior end almost regularly rounded into the basal margin, which is almost parallel with the cardinal line. Beak extends beyond the cardinal line and ter-

minates in an acute point about two-sevenths of the entire length of the shell from the anterior end. A sulcus arises on the umbo of each valve and extends, gradually widening, to the postero-basal margin of the shell, where it appears as a projection, beyond what would otherwise be the termination of the basal margin and posterior slope. A shallower and less defined sulcus occurs anterior to the above on the lower half of the shell, but does not interfere with the basal margin. Posterior to the sharp, angular, umbonal ridges that extend from the beak to the end of the projection at the postero-basal margin, there is a wing-like extension formed by the prolongation of the cardinal line beyond the postero-basal part of the shell, and having a straight posterior end directed backward to the lower extension of the angular umbonal ridges. The superior point of this wing is broken off from our specimen, but, apparently, it did not extend above the cardinal line. Surface of the shell anterior to the angular umbonal ridge marked by exceedingly fine, close, lamellose lines of growth. Wing apparently smooth.

This species is distinguished from *T. faberi* by the comparatively narrower and more cylindrical form of the shell, by the less arcuate form of the wing-like extension, less defined and shorter anterior sulcus, and much smaller size.

Found by S. A. Miller in the lower part of the Hudson River Group, at Cincinnati, and now in his collection.

TELLINOMYA Hall.

It is a matter to be regretted that a generic name so well established and defined as *Tellinomya* should be erroneously attacked, and an attempt made to supplant it with a later and less pleasing word, in any publication bearing the coat-of-arms of any State. We are led to this observation by a recent publication of the Geological Survey of Minnesota, wherein an attempt is made to substitute *Ctenodonta* for *Tellinomya*. It is admitted that *Tellinomya* was defined and illustrated by Hall several years before the word *Ctenodonta* was applied to the same genus of shells, but it is erroneously stated that *Tellinomya* was preoccupied, and for that reason can not stand.

Tellinomya was not preoccupied under any rules or laws of nomenclature previous to its use by Hall.

Tellimya was a name used by Brown in 1827, but that word does not sound like *Tellinomya*, nor can it be coined from *Tellina* and *Mya*, from which *Tellinomya* was derived. When a generic name is compounded from two other genera the word can not be corrupted by dropping a syllable from either one, for the radical and essential parts of the constituent members must be retained, and no change made, except in the variable terminations. We have not the work of Brown at hand, but would suppose, from the structure of the word *Tellimya*, that, possibly, he undertook to derive it from the Greek word *tello* and the genus *Mya*, and intended it should signify the dawn of the genus *Mya*, and, if so, there was no such inappropriateness in the word as to make it nugatory. If, however, he intended to coin the word from *Tellina* and *Mya*, and spelled it *Tellimya*, the name was dead when printed, and beyond the lines of systematic nomenclature from that moment and ever afterward.

But the author in the Minnesota Survey says that nineteen years after Brown coined the word *Tellimya* some one spelled it in a printed catalogue *Tellinomya*, which was the year before the first volume of the Palæontology of New York was printed and distributed. But the printed catalogue gave no vitality to the word *Tellinomya*, nor did the author assume the power to make it do so. A catalogue name is not a publication under any of the rules of nomenclature, nor does the correct spelling of a word in a catalogue give any strength to an original bad spelling of it. Hall delivered his manuscript to the State Printer in 1846, and it is only fair to presume that he catalogued the name *Tellinomya* prior to its use in a catalogue by any other person, and especially before it appeared in the printed catalogue above referred to, though, under the laws of nomenclature, it is idle to talk about the date of a catalogue, whether it is printed or not.

Brown may have coined his word *Tellimya* from a man named *Tell* and the genus *Mya* and, if so, it stands by the side of *Agassizodus*, *Collettosaurus*, *Millericrinus*, *Worthenopora*, and many other words coined in like manner. Looking at the words *Tellimya* and *Tellinomya* from any point of view,

they are distinct generic names; they can not have the same origin; they can not have the same meaning, and they do not sound alike. There is no law, rule, or reason for claiming that the word *Tellinomya* was preoccupied by the use of the word *Tellinmya*, and yet, there is no other excuse offered for discarding *Tellinomya*. We do not suppose any author will follow the erroneous innovation, nevertheless it is a fact that synonyms burden science.

PALÆOCONCHA FABERI S. A. Miller. .

Under the name of *Ctenodonta obliqua*, Hall, Mr. Ulrich has arranged *Palæoconcha faberi* as a synonym in a recent publication on the Lower Silurian Lamellibranchiata of Minnesota, and to this, on page 605, he has added the following comment:

“Dr. S. A. Miller, in the work above referred to, erects a new genus, *Palæoconcha*, and a new family for the reception of the present species, which he divides into two species, giving to the larger form the specific name *faberi*. But this new genus and family have no right to recognition, since they are based entirely upon erroneous observation, he having come to the conclusion that the hinge in these shells was not denticulated and probably edentulous. Through the kindness of Dr. Miller, I had an opportunity to examine a number of the specimens (excellent casts of the interior) used by him in defining his genus. Even among these I noticed several that retained undeniable evidence of the denticulate hinge.”

A brief history of the subject matter is as follows: In 1845 Prof. James Hall very briefly described, without illustration, in the American Journal of Science and Arts, some minute fossils from Cincinnati, and among them was one he called *Nucula obliqua*. The definitions were so imperfect that it is probable the names would have sunk into oblivion had it not been for the fact that the Cincinnati collectors knew the locality from which the minute fossils were taken. In 1870, the late C. B. Dyer took one of the authors to a place near Calhoun and Vine Streets, where he said the minute fossils

were originally found. (The place has been covered with houses for the past twenty years or more). Three or four bushels of the dirt and friable materials were collected, sent home in an express wagon, and the minute fossils carefully washed out. Subsequently, a large lot of the minute fossils, as will be seen on page 139, of Volume I, of the Ohio Palæontology, were presented to the Smithsonian Institution, subject to their use, by Prof. Meek, for the Ohio Geological Survey, and among these were numerous specimens of what it was supposed Hall had called *Nucula obliqua*. Meek had no hesitation in coming to the conclusion that the fossil did not belong to the genus *Nucula*. He had grave doubts about it belonging to *Tellinomya*, and when he described it he called it *Tellinomya ? obliqua*. He described it with, "hinge unknown." And he expressed the opinion that it would be a *Tellinomya*, if the hinge which he had not seen "is crenulated." Later this species was found in great abundance on slabs, at an elevation of about 175 feet above low-water mark, near Plainville, in Hamilton County; from fifty to one hundred specimens sometimes occurring on a single slab, and following this, in 1874, it was republished in the Cincinnati Quarterly Journal of Science, p. 229, under the name of *Tellinomya ? obliqua*, and it was said that "it should be regarded as a common fossil." The authors of this paper can each say he has examined thousands of specimens of the species *obliqua* and that he has never seen any evidence of a crenulated hinge line. Moreover, it has been a matter of common observation among collectors for the past twenty or twenty-five years that it is strange that no one has ever found the hinge of this little species.

Fifteen years or more ago, Prof. J. P. MacLean collected a lot of fossils in the northern part of Butler County, and one of the authors collected the same species in considerable abundance in the same geological range, near Versailles, Indiana, which were figured and described in 1889, under the name of *Palæoconcha faberi*. The particular specimens illustrated, and on which the genus and species were founded, are in the collection of Mr. Faber, and have never been in the possession of S. A. Miller since he wrote the definition, in the Spring of 1889. Other specimens from both typical

localities are in Mr. Miller's collection, as well as in Mr. Faber's collection. When *Palæoconcha faberi* was defined, it was distinguished from *obliqua* by its greater proportional height, by the prolonged beaks projecting high above the hinge-line, the less oblique form, and generally larger size. No one having any knowledge of shells ever supposed the two species are identical, and the question presented was whether or not they could be congeneric. The reader must bear in mind that all the specimens belonging to these species then known were casts, and no part of the shell had ever been found. The number of specimens of *Palæoconcha faberi* in the two collections number several hundred, and each of them was carefully and thoroughly examined by each of the authors, with the aid of good magnifiers, and not a vestige of evidence of a crenulated or denticulated hinge was discovered or can be discovered in any specimen belonging to either collection. The form of *Palæoconcha faberi* precludes the probability, if not the possibility, that it can belong to the genus *Tellinomya*, for no one can conceive of a shell having a cast with such long, close, sharp-pointed beaks, opening on the wide, denticulated hinge of a *Tellinomya*. The evidence thus far adduced amounts to this, that the form of *obliqua* is not inconsistent with a *Tellinomya*, but there has been no evidence discovered to show that it is a *Tellinomya*; while the form of a *faberi* shows it can not be a *Tellinomya*, and there is no evidence to prove that it can belong in the same family with *Tellinomya*. But there is further negative evidence on the subject, which we will now proceed to present.

The species of *Tellinomya*, which occur in the Hudson River Group, in Indiana and Ohio, have thicker shells, in proportion to their size, than belong to any other genus of the Lamellibranchiata found within the Group, and the shells are more abundant in proportion to the number of casts than they are in any other genus. The denticulated hinge lines of each species are common wherever the species occurs. We find the denticulated hinge lines of *Tellinomya levata* and *T. pectunculoides* as frequently as we find a good shell or a good cast of either one, though neither species is common. The cast of *Tellinomya levata* var. *occidentalis* of Meek has never been found, though not less than fifty specimens with the shell on

have been discovered. We have never seen but two casts of *Tellinomya hilli*, though we have seen more than two hundred valves of the shells, many of which preserved the denticulated hinge-line. This state of facts in regard to *Tellinomya*, judging from the specimens we have seen and from the illustrations in the books, prevails throughout the Lower Silurian rocks of North America, and we are not the first, by any means, to call attention to it; for Billings, nearly thirty years ago, in describing *T. angela*, said: "The shell is very thick, and rather strongly convex." Others have remarked upon the great thickness of the shells, and nearly every species described is accompanied with an illustration to show the thick denticulated hinge-line. This is what we call the strongest possible negative evidence that *obliqua* is not a *Tellinomya*, and though the negative evidence is thus equally strong to prove that *faberi* is not a *Tellinomya*, yet the negative evidence was never necessary, for we had the most positive evidence arising from its shape to prove that it is not a *Tellinomya*. All *Tellinomya* have wide denticulated hinge-lines, that allowed the valves to be freely opened and spread out, and held the valves in place, when the strong adductor muscles closed them. No such wide hinge-line and no such spreading of the valves could have existed in the case of *Palæoconcha faberi*. Indeed, every indication is in favor of the supposition that *Palæoconcha faberi* had a very thin shell, with very little pearly matter, rarely capable of preservation, and that the valves were held together by an external ligament, and could be opened only a short distance by the muscles, but never spread wide as in *Tellinomya*. We have now, however, a fine valve of *Palæoconcha faberi*, with the hinge-line well preserved. The hinge-line is linear, without any thickening, except immediately below the beak. There are not the slightest denticulations, crenulations, or irregularities on the hinge-line. It is absolutely edentulous. The ligament was external, and the beaks projected beyond the ligament.

Having thus determined the necessary generic characters of *Palæoconcha faberi*, it will be seen that all the probabilities are that *obliqua* possessed a thin shell, rarely, if ever, capable of preservation, and that the valves were held together exclu-

sively by an external ligament, at the hinge-line, and that it, too, is a true *Palæoconcha*. There is no other genus into which either species, with our present knowledge, can be placed, and yet, there may be a possibility that they are not congeneric, though we think it is exceedingly improbable. In any event, *Palæoconcha* is a good genus, and *Palæoconcha faberi* is a good species.

CRANIA ALBERSI n. sp.

Plate 8, Fig. 17, magnified three and a half diameters; Fig. 18, magnified one and three-fourths diameters; Fig. 19, lateral view, magnified three and one-fourth diameters.

Shell small, subcircular or irregularly subquadrate, probably depending in outline more or less upon the object to which it attached. Dorsal valve quite convex or subconical; apex acute, subcentral, or situated about one-third of the length of the valve from the cardinal line. Surface marked by fine radiating striæ, which rapidly increase in number by implantation from near the apex to the margin, but which increase in size very little, if any, toward the margin. Our specimen is also marked by a few larger transverse ridges, that may have been produced by the foreign substance to which it attached during its growth or by some other abnormal cause. The radiating striæ cross the transverse ridges, and hence constitute the normal surface ornamentation. No lamellose lines of growth.

When this species is compared with *Crania lælia*, it will be noticed that it is much more convex, and the radiating striæ are much finer and more than twice as numerous. *Crania lælia* has been rarely found at the top of the hills at Cincinnati, while it is quite common in the higher rocks at Richmond and Versailles, Indiana, and in Butler and Warren County, Ohio. The range, so far as known, is confined to the upper 400 or 500 feet of the Hudson River Group. This species is founded on a single very fine specimen, collected by C. L. Faber near the base of the Hudson River Group, at Bold Face Creek, just below Cincinnati, at a range 300 feet

lower than we have ever known *Crania lælia* to be found. We do not know what, if any value, as a specific character, to place on the transverse ridges, but the broad convexity of the dorsal valve, and fine, dense, radiating striæ, will readily distinguish the species from any other that has been described.

The specific name is in honor of August Albers, an active Cincinnati collector and artist.

HYOLITHES VERSAILLESENSIS n. sp.

Plate 8, Fig. 20, magnified four diameters; Fig. 21, transverse section and convex side of a fragment magnified four diameters; Fig. 22, flattened side of same magnified four diameters.

This is a small species, ordinarily about two-tenths of an inch in length, and never exceeding three-tenths of an inch in length. Transverse section subtrigonal, and sometimes one angle becomes so obtuse as to make a transverse section planoconvex. One side is always much wider than either of the others, and the angles adjacent thereto are usually much more acute than the other one. The broad side is slightly convex. The apex is sharp-pointed. All our specimens are casts and very smooth. While there are not many characters to ascribe to this species, nevertheless it is doubtless a *Hyolithes* quite different from anything hitherto described.

It is quite common in the upper part of the Hudson River Group, at Versailles, Indiana, associated with *Palæoconcha faberi*, *Cyclora pulcella*, and other small fossils. It is in the collections of both authors.

HYOLITHES (?) DUBIUS n. sp.

Plate 8, Fig. 23, transverse section and side view, magnified in length four diameters and in width three diameters.

This is a very small species, rarely exceeding two-tenths of an inch in length. Transverse section circular. It increases very little in size from the commencement at an obtuse point.

Sometimes it seems to be slightly curved. All the specimens are casts and very smooth. We are not sure that it is a *Hyolithes*, but if it is not it is quite anomalous, and deserves a specific name. Fragments of trilobites occur in the same association, but they are beautifully preserved, the tubercles on *Calymene* never appearing better; while this species is like *Hyolithes versaillesensis*, with which it is associated, and it would seem, therefore, impossible that it should represent the broken spines of trilobites.

It is quite common in the upper part of the Hudson River Group, at Versailles, Indiana, associated with *Palæoconcha faberi*, *Cyclora pulcella*, *Hyolithes versaillesensis*, and other small fossils. It is in the collections of both authors.

AGELACRINUS FABERI S. A. Miller.

Plate 8, Fig. 24, natural size; Fig. 25, magnified two diameters.

This species is founded upon a single specimen, that is very much broken up and attached to the valve of an *Orthis occidentalis*. It is about the size of an average *Agelacrinus cincinnatiensis*. The body is circular, depressed planoconvex, and composed of numerous squamiform plates that imbricate inward from the periphery toward the center. The larger plates occur in the rim that surrounds the extremities of the arms. The arms are much broken up in our specimen, but there seem to be four sinistral and one dextral, composed of interlocking plates, as is usual in this genus. The surface of all the plates is densely and beautifully tuberculated.

This species is distinguished from all others, in rocks of the same age, by the tuberculated plates. It is also distinguished from *Agelacrinus cincinnatiensis* and *A. pileus* by the absence of the great number of small plates that form the periphery in those species, and also by having the larger plates of the body, in the rim, that surrounds the ends of the rays.

Found by Mr. C. L. Faber, in whose honor the specific name is proposed, in the extreme upper part of the Hudson River Group, about half way between Osgood and Versailles, Indiana, and now in his collection.

BEYRICHIA HAMMELLI n. sp.

Plate 8, Fig. 26, right valve magnified twelve diameters, with a small piece of the border broken away at the antero-dorsal angle.

Carapace medium size, dorsal margin straight and nearly as long as the greatest length of the valves. Anterior and posterior extremities broadly rounded, the anterior being slightly the wider of the two. Greatest width of the valves at the anterior third, where the width is to the length of the dorsal margin about as three is to four. Basal margin rounded, and slightly advancing at the anterior third. Valves moderately convex, with a border on the anterior, posterior, and basal margins, separated from the valve by a sharply-defined line or groove. The border on the basal margin is about one-sixth the width of the valve, and it narrows to about two-thirds that width at the antero-dorsal angle, and to about one-third that width at the postero-dorsal angle. The body of the valve is constricted by two sulci, directed obliquely backward from the basal border of the shell; the anterior one arises at the groove separating the border from the body of the shell, at the antero-basal margin, and when half way across the valve bifurcates, the stronger sulcus being directed forward toward the antero dorsal margin, and the shallower one fading out before it reaches the dorsal margin of the shell. There is thus formed, anterior to this sulcus, a large, convex, rounded area, and between the branches of this sulcus and the dorsal margin a depressed, convex, subtriangular area. Between the two oblique sulci there is a convex ridge more prominent than the rounded area in front, and which extends farther toward the basal margin than either the anterior or posterior convex areas. The posterior oblique sulcus fades out before it reaches the dorsal margin. The area between the posterior oblique sulcus and the posterior extremity of the valve is wider, but not as prominent as the more central ridge between the oblique sulci.

The surface of the valves is distinctly granulous. The margin of the border, as seen on the interior side of the shell, is fringed or ciliated in the same manner as *Beyrichia ciliata*.

This species, when compared with *Beyrichia ciliata*, is proportionally wider; has a wide border, while that species has only a linear border; has deeper sulci and a more convex ridge between them. Judging from some recent publications on the Ostracoda, there are those who would affix a new generic name to this species, but what light that would shed upon its characters, or how it would advance knowledge or assist in classification, we are unable to understand. We think it is a true *Beyrichia*.

Found in the upper part of the Hudson River Group, by one of the authors, at Versailles, Indiana, associated with *Cyclora pulcella*, *Palæoconcha faberi*, *Hyolithes versaillesensis*, and other small fossils.

The specific name is in honor of Mr. J. F. Hammell, the well-known geologist of Madison, Indiana.

STUDIES OF THE DEVELOPMENT OF FIDIA VITICIDA WALSH, WITH DESCRIPTIONS OF ONE NEW GENUS AND TWO NEW SPECIES OF HYMENOPTERA, BY WM. H. ASHMEAD.*

BY F. M. WEBSTER, M. SC.

PREVIOUS HISTORY.

The first published notice of this insect that I can find in our literature extends back only to 1866, when the species was as yet undescribed, and during the Summer of which year the late Mr. B. D. Walsh, afterward State Entomologist of Illinois, received the adult insect from Kentucky, where it seems to have been depredating on the foliage of the grape in great numbers. Mr. Walsh stated in his reply that, although he had taken it in small numbers on the native grape in both Northern and Southern Illinois, this was the first report of their appearance in destructive numbers. The habit of dropping to the ground and feigning death, when disturbed, and of feeding on the upper surface of the leaves were recorded, and the middle of June stated to be the date of its annual appearance in Kentucky. Of the larval stage, Mr. Walsh wrote, tentatively, as follows:

"Most probably, as with the flea-beetle of the grape vine, it is in the larva state that it does the principal part of the damage, and as the larva of all beetles are altogether unlike the perfect insect, you may not have recognized their identity. The larva of this species will be an elongate grub, with a hard, shelly head, a soft body, no wings, of course, six legs in front, and a single "pro-leg," or short, fleshy stump, which it uses as a leg, at its tail; and the color will probably be some obscure shade of pale drab or brown. It will be found sluggishly feeding on the surface of the leaves along with

*These studies constitute the more technical portion of an investigation carried on as Entomologist of the Ohio Agricultural Experiment Station.

the perfect insect, and as soon as they first appear in the Spring you should use every exertion to destroy them. A single female larva destroyed at that time may prevent the generation of a hundred thousand in the course of the Summer; for I have little doubt this species is many-brooded, *i. e.*, that there are several generations of them in one year.”*

Later, in the same publication,† Mr. Walsh describes and figures the insect, giving it the name it now bears, and indicated the points of difference between it and *F. longipes* Melsh. He adds that the beetle had long been well-known to himself and other entomologists, but, except to note the occurrence of a single specimen on a Catawba vine in his garden, and suggest that it might, in future, swarm in other localities besides Kentucky, gave nothing additional. A few months later, in August or September, 1867, the same gentleman acknowledged receipt of the same insect from the vicinity of St. Louis and Bluffton, Missouri, where they were eating both leaves and fruit of the grape. Among the material sent was a single specimen of *F. longipes* Melsh.‡

In his first Report on Insects of Missouri, Professor Riley makes the following statements:

“One of the worst foes to the grape-vine that we have in Missouri is the Grape Vine Fidia, which is represented in the annexed figure. It is of a chestnut-brown color, and is densely covered with short and dense whitish hairs, which give it a hoary appearance. I have found it very thick in most of the vineyards which I visited, and it is almost universally miscalled the “Rose-bug,” which is, however, a very different insect. It is found in the woods on the wild grape-vine, and also on the leaves of the *Cercis canadensis*; but of the tame vines, it seems to prefer the Norton’s Virginia and Concord. It makes its appearance during the month of June, and by the end of July has generally disappeared, from which fact we may infer that there is but one brood each year. The manner in which it injures the vine is by cutting straight elongated holes of about one-eighth inch in diameter in the leaves, and, when numerous, it so riddles the leaves as to

* Pract. Ent., Vol. I, pp. 99, 100, 1866.

† Loc. cit., Vol, II, pp. 87, 88.

‡ Loc. cit., p. 118.

reduce them to mere shreds. The preparatory stages of this beetle are not yet known."*

In 1870, Mr. Riley received the beetle from Bunker Hill, Illinois, where it was feeding on the leaves of grapes.†

In his "Materials for the Study of the Phytophaga of the United States," Mr. G. R. Crotch describes the species *murina*, from the Middle and Southern States, but seems to have overlooked *viticida*, and did not mention it.‡ In his paper on "The Eumolpini of Boreal America," Dr. G. H. Horn unites *murina* with *viticida*, and gives the distribution as being from the "Middle States to Dakota, Florida and Texas."|| He also unites with the species *F. lurida* Leferre, "Catalogus Eumolpidarum," Mem. Liege, 1885, p. 76 (separate).

Prof. H. F. Wickham records *viticida* from the vicinity of Iowa City, Iowa,§ and Prof. Riley has recorded both *murina* and *longipes* as injuring the foliage of grapes at Vineland, Arkansas.¶

This is a summary of all the available information relating to the species up to December, 1893, the time when I began my studies of larvæ sent me from the vicinity of Cleveland, Ohio, where they were said to occur in great numbers about the roots of grapes, causing very serious injury by eating the outer bark.

DESCRIPTION OF THE SEVERAL STAGES.

Of the following descriptions, that of the adult is copied from Walsh; those of the preparatory stages are my own, drawn from material taken from the vineyards about Euclid and Nottingham, Ohio.

ADULT: A, Fig. 1, Pl. IX. Chestnut rufous, punctured, and densely covered with short, grayish-white prostrate hairs, so as to appear hoary. Head rather closely punctured, with a fine longitudinal stria on the vertex. Clypeus and mandibles glabrous and black, the clypeus with a sub-terminal

* First Rep, Inj. Ben. Ins. Mo., p. 132, 1869.

† Am. Ent. and Bot., Vol. II, p. 307, 1870.

‡ Proc. Acad. Sci., Phila., p. 53, 1873.

|| Trans. Am. Ent. Soc., Vol. XIX, p. 198, 1892.

§ Bull. Lab. Nat. Hist. Univ. Iowa, Vol. I, p. 81, 1888.

¶ Insect Life, Vol. V, p. 18.

transverse row of punctures, armed with long golden hairs, the mandibles minutely punctured on their basal half. Palpi and antennæ honey-yellow, verging on rufous, the antennæ three-fourths as long as the body, with joint 4 fully one-half longer than joint 3. Thorax finely and confluent punctured, about as long as wide, rather wider behind than before, the sides in a convex circular arc of not quite 60° , the males with the thorax rather longer and laterally less strongly curved than the females. Elytra punctato-striate, the stria sub-obsolete, the punctures approximate, and rather large but not deep, the interstices flat and with close-set, fine, shallow punctures. Legs with the anterior tibiæ of the male suddenly crooked three-fourths of the way to their tip; anterior tibiæ of the female as straight as the others. Length of male, .24-.27 inch; female, .24-.28 inch.

LARVA: C. Fig. 1, Pl. IX. Length, 8. to 10. mm. Color; body white, head and cervical shield honey-yellow, clouded with white, mandibles and clypeus darker, with the tips of the former and the prominent clypeal suture nearly black; spiracles and claws brownish-yellow, the former and anterior pair of feet sometimes darker. Head considerably smaller than first thoracic segment, which is a little smaller than the second; third equal, from which the body tapers slightly and regularly to twelfth; thirteenth smaller, orbicular and almost rudimentary, containing the vent, the latter forming depressions in the form of the letter Y, and dividing the area into three elevated spaces, on each of which are situated a number of short, decumbent spines, pointing inward, and on the spaces between the two branches of the Y are two larger spines, both of which are erect; there are also groups of shorter spines on the twelfth segment, and with two longer spines, likewise occupy elevated areas; on the ventral surface of all the segments, except the thirteenth and thoracic, are many short, reddish, ambulatory setæ; above, there is a single transverse row of short bristles emanating from small pustules, which are more conspicuous posteriorly. The first spiracle is located between the second and third segments, and is frequently a little more distinct than the others which are located on each segment, from fourth to eleventh, inclusive. On the head, *a*, Fig. 1, Pl. IX, the clypeal suture is

prominent, roughened and broadly obtusely bifid immediately above the base of the mandible, the outer tooth being the smaller, and between it and the larger arises a stout bristle, while others are placed distantly along the crest of the ridge. Mandible, *b*, Fig. 1, Pl. IX, with a broad obtuse tooth on the inner edge toward the tip. The labrum is provided with a stout bristle about midway between the center and the lateral margin, with a closely placed row around the frontal edge, these last being usually broken off in full grown specimens. The somewhat peculiar antenna, *c*, Fig. 1, Pl. IX, is four jointed, the basal being shorter and slightly more robust than the second, from which it is rather indistinctly separated, the third is still smaller, the fourth being of two parts, the outer cylindrical and surmounted by three bristles, while the inner is nearly the form of a right-angled triangle, with the perpendicular innermost, the hypotenuse facing the cylindrical portion and having a somewhat scoop-shaped appearance. Labium thick and trilobed, the outer lobes covered on the upper surfaces with minute, spinular scales; palpi, *f*, Fig. 1, Pl. IX, rather slender, cylindrical, slightly curved and terminating with a single bristle. Maxillæ, *e*, Fig. 1, Pl. IX, well developed, with the inner lobe armed with stout spines, the outer lobe prominent and four jointed.

PUPA: B, Fig. 1, Pl. IX. Length, 6. to 8. mm. Color, white, with pinkish tinge about head, thorax and posterior extremity; head with a semi-circular row of four spines, the frontal pair erect, the other two smaller and divergent; near anterior margin of thorax there is a similar row, likewise placed in the form of a semi-circle, while just behind these is a cluster of four smaller and more erect bristles placed in pairs, the anterior of these being the most widely separated. Anterior femora armed at tip with a short, hooked spine, while above and at one side is a single, straight spine terminating in a bristle, posterior femora armed with a stouter hook and two stouter erect spinular bristles, middle femora unarmed; at posterior extremity are two stout, flattened hooks, whose points extend upward; on the dorsum of the penultimate segment is a row of four distantly-placed decumbent spines, while on the preceding segment is a median, transverse, closely-placed row of four stout, erect spines, each

of the other segments being provided with a single row of minute, short bristles, with two larger ones on the scutellum.

In the majority of my specimens the anal hooks are as described and shown in the figure. In some, however, they are bifid, one hook extending upward and the other downward, in which case the spines are much stouter, while beneath are two very short, stubby, hooked appendages. In one specimen one of the anal hooks is bifid and the other simple, and beneath the former is one of the short appendages, while there are two of these, closely placed beneath the latter.

EGG: The egg is 1.15 mm. long, with the greatest diameter considerably less than one-third the length; form elongated, with the ends equal and obtusely conoid. The shell is very flexible, and when, as is often the case, they are crowded into a small space, the form is often greatly distorted. When first deposited they are of a white color, but soon take on a yellowish cast. The egg period is eight days, though granulation is not clearly visible until the third day; on the fourth, there appears near each end a narrow, semi-transparent band, while the granulation is much coarser; on the fifth, the blastodermic disc is clearly defined, the bands becoming wider; on the sixth, one of the bands has nearly disappeared, and the other has more than doubled in width, segmentation having clearly begun; on the seventh, one band has entirely disappeared, and the semi-transparent space along one side, which is first observed on the fifth day, is now much wider, and extends from the semi-transparent band nearly to the opposite end of the egg, with granulation of blastodermic disc very coarse, and segmentation progressing very rapidly; on the eighth, segmentation more clear, and quickening was first observed; on the ninth, the young larva appears, being but very slightly larger than the egg, from which it gains exit by backing out, the brownish tips of the mandibles being clearly visible through the shell.

HABITS OF THE ADULT.

In Northern Ohio the larvæ pupate, largely at least, in June, though I have found pupæ in limited numbers on the eighth of August, which transformed to adults two days later,

and adults are abroad in very limited numbers the first week in September. It is probable that these were delayed individuals, the result of larvæ which did not fully mature the previous Autumn. On pupating, the larval skin is pushed off posteriorly, and may be found in a compact disc in the earthen cells, after the adults have emerged. A very few pupæ may be observed as early as the first week in June, and by the 23d fully ninety per cent. of the larvæ have passed into this stage, the period of which is not far from a fortnight. At this date, the adults begin to appear, and pairing at once commences, both sexes now feeding on the lower leaves, though, later in the season, they are found higher up on the youngest and most tender foliage. The feeding is done entirely upon the upper surface of the leaves, except where the fruit is the object of attack, and is done by gathering a quantity of the substance of the leaf in the mandibles and jerking the head upward, after which the body is moved a step forward and another mouthful of food secured as before. After securing a few mouthfuls in this way, they move to another place and begin again, thus eating out numerous chain-like areas of irregular length, as shown in Fig. 3, Plate IX. On varieties of the grape having a velvety under-surface to the leaves they eat only to the lower epidermis, on others, entirely through the leaf. When alarmed, they usually draw up the legs and fall to the ground, where they are not easily distinguishable from the soil; if however, they do not drop at first alarm, or during a high wind, they will probably pay no attention to almost any amount of disturbance, and can be readily caught with the fingers. In the insectary, adults lived upward of two months, though, in the vineyard, they have mostly disappeared by August 1.

It would seem that an insect whose larvæ fed upon the roots of their mutual food-plant would place its eggs in a position most convenient for the young to reach their sustenance, but in this almost the contrary seems to be the case, as the eggs are deposited in or under the bark of the previous years, or even an older growth, and often several feet above and beyond the roots, and the young larvæ, whose feet are not fitted for walking on vertical or steeply inclined surfaces, tumble to the ground and find their way to the roots as best

they can. This mode of oviposition, however, finds a parallel in a closely-allied species, *Adoxus obscurus* Linn, whose larvæ, in Europe, also feed on the roots of the grape, and the eggs, according to the studies of Mr. E. Dupont, are deposited on the leaves.* Although *A. obscurus* is a grape-infesting insect in Europe, in America, neither the species itself, which occurs in Colorado, Nevada, and California, or the variety *vitis* Fab., which extends from New Hampshire westward to Lake Superior, Utah, Colorado, and Washington, are known to affect the grape. With the species directly under consideration, the eggs are, as a rule, placed under the slightly loosened bark, as shown in Fig. 4, Plate IX, several dozen being frequently found in a single cluster, the ends pointing obliquely toward a common center. The number of eggs deposited by each female is as yet undetermined, but as giving an idea of the number placed on a single vine, over 700 have been taken from one vine, while from a section sixteen inches in length and one inch in diameter, from the main trunk of another, I took 225 eggs. Though I have once or twice found eggs pushed down between the earth and the base of the vine, there seems to be no partiality shown for this or any other locality on the vine, the sole object being to secure a place wherein to secrete them. However anomalous this method of oviposition may appear to us, we must not lose sight of the fact that the natural habit of the wild grape differs somewhat from those of the vineyard, and the habit of oviposition has been followed by the female long enough in the past to thoroughly adapt the anatomical structure of the ovipositor for its requirements. The ovipositor consists of a retractable, telescopic arrangement, having a somewhat loose and baggy appearance, but terminating with a slender, flattened, more chitinous and rigid appendage, from 1.3 mm. to 1.8 mm. in length, the tip of which is provided with a pair of short, obliquely-truncated forceps, black in color, except at the ends, which are white and provided with a number of short, stiff hairs. At the base of these is a couple of slight lips, which are rounded in front, apparently forming a socket for the reception of the end of the egg. See Figs. 2, *a*, *b*, *c*, Plate IX. From what I have observed respecting the oviposition of

*Progrès Agricole et Viticole, Vol. X, pp. 576-578, Sep., 1889.

other insects, it would seem that one end of the egg was held in the forceps and, while prevented from slipping backward, by the lips, as described, was deftly pushed under the bark and left there. This last segment of the ovipositor appears too slender to admit of the egg passing down internally to the forceps, though such may be the case, and I am puzzled to know how else the former can be secured by the latter. It really looks as though the oviduct might end in a loose sack, accessible in some way to the retracted forceps, which, grasping the egg, carries it outward to its place of deposit. The eggs, though they adhere quite tenaciously to each other, are less strongly attached to the vine or bark, and I have found them lying on the surface of the ground under the vines, having doubtless been loosened and detached by the swaying of the vine in the winds.

HABITS OF THE LARVA.

Some of the habits of the larva have been indicated in the foregoing. When the young larva drops to the ground it runs about quite actively, but I have never observed them attempting to dig downward. If they find a crack or crevice they enter it, and probably some of them reach the roots in this way, but I think it more probable that the larger number go downward at the base of the vine. Still, as the little fellows will live for a week or more without food, it is not strange that many of them should find their way to one of the many fresh succulent fibrous roots that are found near the surface of the ground, though I have seen them die on dropping on the hot sand. However, the fact that a large majority of the worms are found near or directly beneath the point where the large roots leave the trunk, is indicative of the point of entrance of the larger number of the very young worms. It would appear that the very young larva, after it has fed for a short time on the small fibrous roots, turns its attention to the larger and tougher portions, eating off the bark, as shown in Figs. 5, 6, Plate IX, and following the smaller ones outward. Where the larvæ are numerous—and as many as sixty-eight have been taken from about a single vine—the injured roots simply rest on a bed of the castings of the

worms. In spring, larvæ have been found fully three feet from the trunk and nearly a foot below the surface. The larva appears to develop very rapidly, many having reached their full growth by the middle of August. When full fed they work their way to one side and form earthen cells, within which they remain without food until the time of pupation the following June, curled up in such a manner as to bring the head in close proximity to the ventral surface of the posterior segment. In April I have found an occasional larva less than half grown, and though these were in cells when found, it is probable that they return again to the roots and finish their growth, transforming to adults even as late as the middle of August, an occasional adult being observed abroad as late as September.

NATURAL ENEMIES.

As is usual in cases of an over abundance of the individuals of a species, these were quite abundant in the vicinity of Cleveland, Ohio, where *Fidia viticida* developed in great numbers during the past Summer. While the adults are doubtless destroyed by birds to some extent, no such cases were noticed, nor were insectivorous birds present in unusual numbers. The same may be said of predaceous insects, no enemies of the larvæ having been observed in situations leading one to suspect them of destroying either the larvæ or pupæ. With the eggs, however, the case was quite different. The little brown ant, *Lasius brunneus*, var. *alienus*, was observed several times in the act of feeding upon them, though they could only reach such as were much exposed. A small mite, possibly *Tyroglyphus phylloxerae* P. & R., though Dr. Geo. Marx, of Washington, D. C., was not able to refer the immature specimens sent him to the proper genus, was frequently observed to approach a cluster of eggs and extract the contents of several in succession, while still another smaller mite, resembling *Hoplophora arctata* Riley, was several times found similarly engaged. The remaining two species are described in the following pages, by Mr. Ashmead.

The fact of *Fidiobia flavis*, Ashmead, being a parasite on coleopterous ova having been privately called in question by

both Mr. Ashmead and U. S. Entomologist Mr. L. O. Howard, owing to its belonging to a group supposed to be parasitic on Diptera exclusively, I give full details of the rearing of the specimens from which the original description was drawn. The cluster of eggs were given me by Prof. Hobbs, of the Western Reserve Medical College, who found them on a vine, located practically as shown in Fig. 4, Plate IX, and removed them therefrom in a body, they remaining attached to each other, and placed them in a watch glass in his laboratory. On looking at them some days later the pupa could be distinguished within the shell, both the eyes and ocelli showing very clearly. This was on July 20, and during the following four days I watched them carefully, at the end of which time I distinctly saw one move about within the shell of the egg, and later make its way forth. Another individual was removed from the shell, it having perished prior to hatching. No one saw these eggs deposited by the parent beetle, but there was no difference either in form or color from those from which *Fidia* larva emerged, and the only possible way that an error could be accounted for would be to suppose that a minute fly, whose eggs exactly counterfeited those of *Fidia*, had oviposited among the eggs of the latter, and the *Fidiobia* had detected them and placed her own ova in them. This appears to me to be an improbability, to say the least. With *Brachysticha fidiæ*, Ashmead, though I did not witness the deposition of the eggs by the beetle, I did observe the parasite oviposit in them, on August 4. On the 14th the pupa was well defined within the shells, and on the 18th this stage had advanced so that the eyes were clearly visible, being about as were the *Fidiobia* when I first saw them. The adults emerged on the twenty-first day after eggs were deposited.

A NEW GENUS AND SPECIES OF PROCTOTRYPIDÆ
AND A NEW SPECIES OF BRACHYSTICHA,
BRED BY PROF. F. M. WEBSTER.

BY WILLIAM H. ASHMEAD.

FAMILY PROCTOTRYPIDÆ.

SUB-FAMILY PLATYGASTERINÆ.

FIDIOBIA, gen. nov. Head transverse, as wide as the widest part of the thorax; viewed from in front, wider than long; the frons smooth, subconvex, ocelli 3 in a triangle, the lateral much nearer to the eye margin than to the front ocellus; the antennæ inserted near the mouth, in ♀ 8-jointed, ending in an ovate 3-jointed club; the scape subclavate as long as the face, the pedicel cyathiform, a little longer than thick at apex; the funicle 3-jointed, the first two joints not or scarcely longer than thick, the third wider than long. Thorax sub-ovoid, a little longer than wide, the mesonotum smooth without sharply defined furrows, although these are more or less slightly indicated posteriorly by two longitudinal impressions; scutellum lunate, flat, separated from the mesonotum by a delicate transverse line, but without fovea; metanotum with two minute foveolæ; wings hyaline, without nervures.

Abdomen sessile, oblong, truncate behind and a little narrowed toward base, the first segment wider than long, the second occupying the whole of the remaining surface, the terminal segments evidently being retracted.

This genus should be placed in my table, Monogr. N. A. Proctotrypidæ, p. 263, between *Anopedias* Först. and *Amitus* Haliday.

It agrees with the latter in having 8-jointed antennæ, but their structure is totally different. They are very short and the club is 3-jointed, while in *Amitus* they are long and the club is unjointed; otherwise, in shape and structure of thorax

and abdomen, there is not a particle of resemblance, these characteristics more closely resembling those in *Anopedias*.

It also bears some resemblance to the genus *Phanurus* Thoms. in the tribe *Telenomini*, but it evidently can not be placed here on account of the veinless wings and the structure of the abdomen, although its habits would seem to indicate an affinity with this group.

FIDIOBIA FLAVIPES, sp. n. ♀ — Length, 0.6 mm. Black, polished; legs and antennæ yellow; thorax without distinct furrows, smooth, with only slight indications of furrows posteriorly, but not sharply defined; wings hyaline, veinless; abdomen oblong, sessile, the first segment wider than long, the second very large, occupying most of the remaining surface, the following being usually retracted with it, and thus making the abdomen appear truncated at apex.

Hab.— Euclid, Ohio.

Described from specimens bred by Prof. F. M. Webster, July, 1894, from the eggs of a Coleopteron *Fidia viticida*, on grape-vine.

FAMILY TRICHOGRAMMIDÆ.

BRACHYSTICHA FÖRSTER.

BRACHYSTICHA FIDIÆ, sp. n. ♀ — Length 0.65 mm. Head, except eyes and thorax, pale brown or brownish-yellow; the conical-shaped but depressed abdomen dark fuscous or black; wings hyaline, broad, pubescent, with a short marginal fringe, the pubescent not arranged in regular rows; legs brown or fuscous, the tips of femora, tips of tibiæ and tarsi yellowish.

The head antero-posteriorly very thin, with a facial impression; the antennæ inserted far down on the face, 6-jointed (scape, pedicel, ring-joint and a 3-jointed, fusiform, pubescent club); thorax with a longitudinal median impressed line; while the abdomen is long, conically-pointed, but depressed above.

Hab.— Euclid, Ohio.

Described from specimens bred by Prof. F. M. Webster, August, 1894, from eggs of *Fidia viticida*, on grape-vine.

This species comes nearest to *Trichogramma acuminatum*, Ashm., Can. Ent., 1888, p. 107, which should probably be referred to this genus, but differs decidedly in the color of the legs and abdomen.

THE PREPARATION AND CARE OF INSECT COLLECTIONS.

BY CHARLES DURY.

The object of this paper is to answer the question, "How can I make a collection of insects, and what are the best methods of killing, pinning, mounting, and taking care of such material after it has been prepared?" A glance at many of the collections shows faulty methods of preparation, and the need for improvement in this direction. The collector should provide suitable implements for capturing and killing his specimens. Be sure to start right in this respect. I use the following: A large, strong, gingham umbrella, which is used by holding it inverted under the foliage of trees, bushes, and dead branches, which are beaten over it with a long stick, jarring coleoptera, hemiptera, and other insects into it; sweeping net made of strong muslin, sewed to a stiff steel ring, which is firmly fixed into a handle eighteen inches long (the ring being thirteen inches in diameter); this muslin bag should be twenty inches deep. This is a most effective implement for sweeping and beating grasses and weeds, for the capture of small Coleoptera, etc. For sifting ants' nests, moulds, moss, leaves, and rubbish, use a sifting net which is made by sewing a muslin bag to a stout iron ring, ten inches in diameter; the bottom of the bag is a round piece of wire netting, with one-quarter-inch mesh. The material to be sifted is placed in the net and shaken over white paper, and as the insects crawl about they can be readily seen and picked up. For the capture of aquatic insects, I use a net made of fine wire netting, sewed with soft wire to an iron ring, which has been fixed in a long handle. To capture Lepidoptera, Hymenoptera, and all flying insects, I use a net made of bobinet, sewed to a circular ring twelve inches in diameter, with a handle thirty-six inches long. These implements can be purchased from dealers who advertise in the entomological

journals, or the beginner can make them himself at trifling expense. When the insect is captured it should be quickly killed. The best material for this purpose is cyanide of potassium. To prepare a bottle for Coleoptera, Hemiptera, etc., cut some strips of soft paper, crumple, and place them in bottle loosely; on top of this, place several bits of cyanide wrapped in paper; cork up tightly with rubber stopper. After each day's collecting, the paper should be taken out and dried, if damp, or renewed, so as to keep the bottle as dry and clean as possible. The specimens should not be allowed to remain longer in the bottle than is required to kill them. To prepare a jar to kill Lepidoptera, use a candy-jar with wide mouth, and in the bottom of this lay a few lumps of fused cyanide, over which pour plaster of paris, mixed thick with water, to cover the cyanide about one-quarter inch deep. Cork up tight. Several bottles of different sizes should always be carried on a collecting trip. Glue a strip of muslin around outside of jar to prevent breakage, as the swelling of the plaster frequently cracks the glass. Do not pin the smaller Coleoptera or Hemiptera. Cut small card-board triangles, five-sixteenths of an inch long, run the pin through the larger end and mount the insect, with glue, on the tip, always placing the insect on the left side of the pin. In other words, when the pin is stuck in bit of cork in front of you, the triangle should point to the left, and the head of the insect point away from you. Pin the larger beetle through the right elytron or wing cover, near base. Pin so the forward part of insect will be slightly raised. Pin Hemiptera through the scutellum. Other insects through the thorax. Always fold the legs under the body to prevent the liability of breakage. Do not spread the legs, as is sometimes recommended, unless characters are to be shown by doing so. In Coleoptera I bend the antennæ back along the body to prevent them from being broken. I have used the following glues for mounting insects or gluing duplicates to card board: One-quarter ounce of gum arabic, one-eighth ounce gum tragacanth, dissolve in hot water, and to this add one-half teaspoonful of glycerine and four drops of carbolic acid. This glue should be of the consistency of cream. Or dissolve bleached shellac in alcohol to the consistency of thick cream. This glue sets quickly, but

should not be used for mounting duplicates on card board. Another glue is made of gum arabic, sulphate of alumina, glycerine and acetic acid dissolved in water. Some collectors use Spaulding's prepared glue. The desiderata is to get a quick-setting glue that will hold tenaciously and not be too brittle when dry. In mounting small insects on triangles use only a small particle of glue, so as not to obscure characters. Above all things keep the specimen clean and perfect. For pinning through the triangles a No. 2 Carls bader pin may be used, and for pinning the larger beetles a No. 2 or 3 is right. In pinning all insets use as small a pin as possible to secure stability in handling. Use nothing but the best pins obtainable. The Klaeger pin is a good pin. The particular localities in which to collect insects vary some in each neighborhood. In Coleoptera we get a faunæ along the rivers and low bottom lands that is somewhat different from that of the higher forest. Dead beech timber produces some of our most interesting things in this order, and is very prolific in species. For sweeping, with the sweep-net, the edges of forests that have a rank growth of vegetation are good. Localities where cattle and hogs are pastured should be avoided. For diurnal Lepidoptera, I have the best success in the early part of the day, say from 9 to 12 M., and for these all localities should be searched. For sugaring the trees at night, which is done by smearing a mixture of sour beer and strong brown sugar on them, care should be taken to select trees along paths that are easy of access, so they can be visited readily, and with a dark lantern the desired specimens selected and the collecting jar placed over them. I always prefer to spread Lepidoptera while fresh, though diurnals can be nicely collected in papers folden in triangular shape. These can be softened afterward by placing them in a crock which has the bottom covered with wet sand. Place some carbolic acid (crude) on the inside of crock to prevent mould. It takes several days to soften thick-bodied insects, but the process can be hastened by pouring a little boiling water on the sand.

When Lepidoptera are softened and the wings set in a different position from the one in which they have been originally dried, a small particle of shellac glue should be touched on the base of wings to hold them exactly in place when dry.

I find this a very important point in mounting dry Lepidoptera, but care must be taken not to allow the glue to soak through and deface the upper surface. For spreading Lepidoptera make a number of setting boards, with grooves for the reception of body and legs. These grooves should be wide enough to freely admit the body and folded legs, the flat portion of boards on which the wings are to rest should have a slight inclination upward toward the outer side. These boards should be made of soft pine, with a strip of cork glued along bottom of groove, in which the point of pin should rest. About one-fifth of the pin should project above the body of the insect. All specimens should be pinned at the same height on the pin, to secure uniformity in the appearance of the collection. Individual tastes differ as the height the insect should be placed on the pin and also as to the angle of the wings, but my experience has been that it is best to place them as high as possible, so as to allow enough of the pin to project above the body to make moving the specimen easy and safe. The specimens should always be handled with insect forceps, which can be procured of John Akhurst, of Brooklyn, N. Y. Good insect pins can be procured from Ferd. Wagner, optician, Cincinnati, Ohio. Boxes and drawers to contain the collection are of different sizes and shapes, but should be as tight as possible. For Coleoptera, Hemiptera, Diptera and Hymenoptera a box 9 x 12 is about the right size, while for Lepidoptera a drawer 18 x 20 inches is preferable. My collection of North American Coleoptera is contained in 105 boxes, made of well-seasoned pine, with a rabbit on which the lid shuts down very tightly; the top and bottom are two-ply pine veneers, cross-grained, glued together. The inside is shellaced and the bottom is covered with a sheet of compressed cork, which is very poor stuff, indeed, as some of the sheets are almost as hard as an oak plank. This stuff is prepared in New Jersey, and has given me much trouble. While sheet cork does not look so neat, yet it is a more practicable material. The outside of the pine Coleoptera boxes are finished in hard oil. The lids are hinged on, and the box is held shut with a brass hook at each end. They make a very useful box, if well made. None of mine have ever cracked. They were made in Cincinnati. To have the boxes and

drawers absolutely tight or well disinfected, is a matter of the utmost importance, for on this the preservation and perpetuation of the collection depends. "Eternal vigilance" is the price of these things. The unerring accuracy with which "museum pests" seek out and devour all unprotected material, is marvelous and very disastrous. Chief of all destroying agencies are the so-called "museum pests." In this term is included small beetles belonging to the family *Dermestidæ*. Small moths (*Tineans*) and "mites." The most common are the *Dermestes*. Mr. Hornaday, in speaking of *Dermestes lardarius*, says: "If an island of bare rocks was born to-day in the middle of the Pacific Ocean and an unpoisoned skin of bird or mammal laid down upon it, I wager that *Dermestes lardarius* would find that skin before sunset." If you were to prepare a skin without poison and lock it up in the bowels of a burglar-proof safe, not to be opened for six months, at the end of that time you would find it swarming with *Dermestes*. If you ever omit to poison anything in the shape of a vertebrate specimen, be sure your sin and the beastly bugs will find you out." Unprotected insects are even more susceptible to these attacks than preserved specimens of the higher animals. The mites generally gain access to collections by being introduced with infected material. *Dermestes* and moths introduce themselves, attracted by the odor that comes from dried specimens. The mischief is not done by either the adult beetle or moth, but by their larvæ. The adult female deposits her eggs with unerring accuracy on the proper food, and when the eggs hatch the trouble begins. The presence of pests in a specimen can be detected by the excrementitious dust that falls from it when it is jarred or shaken. I have never had moths in my insect collections, but once had a number of boxes infected with a "mite" which Dr. Hagen identified as *Tyroglyphus entomophagus*. This was the most fearful pest I ever saw, and its tenacity of life was surprising. I used cyanide of potassium fumes, in the boxes so strong as to destroy the pins without killing all of the mites. Chloroform, ether, benzine and camphor had but little effect. The habit of the mite was to burrow into the specimen between the segments or through an opening. Once inside, it would eat and multiply until the thorax would

drop off, revealing the inside swarming full of mites, and a constant stream of the pests crawling down the pins and spreading to other specimens. My entire collection was threatened. I found heat, sufficient to completely destroy the pest, ruined the specimen. If they were saturated with a solution of corrosive sublimate and alcohol they were safe. But at last I tried the fumes of bi-sulphide of carbon. Pasting up the boxes tight, I made a hole in the side and injected this pungent liquid, closing up the hole tightly afterward, and in this way I succeeded in killing every thing. Dr. Hagen wrote me of this insect: "The most dangerous pest I know; we once had it in the museum (Cambridge), and though everything was tried, I was unable to get rid of it, until I burned up many boxes of valuable insects." This mite is a very light colored, plump and shining creature, with an unequaled ability for devouring and reproduction. Fortunately, but few of the American entomologists seem to have had it in their collections. They cost me much time and trouble in the two years I battled with them. As a repellent material to keep pests out, benzine and ether are too volatile; naphthaline is much better. I use the soft flaky scales, and put a pinch in the corners of the boxes. The cones, which are molded on pins, are good, and can be pinned in the corner of the boxes, but care must be taken that they do not partly evaporate and fall from the pin, tumble about in the box and break the specimens. When new material is received, it should either be quarantined, or closely watched for some time, to see that it is not infected with eggs which are liable to hatch at any time, and do mischief before being discovered.

Mr. Ulke, of Washington, washes all coleopterous insects with ether before introducing them into his boxes. Butterflies and moths that are suspected had better be subjected to the fumes of bi-sulphide of carbon, which will destroy any pests that may be about them. I think this will also destroy the eggs of pests, which naphthaline will not do. I have been convinced that while naphthaline fumes will retard the hatching of the eggs, it will not kill them, and as soon as the naphthaline is removed, they are liable to hatch. It is not desirable to attempt to poison all the specimens in a collection to prevent them from being eaten, for obvious reasons. It is much

better to rely on the tight or disinfected boxes to insure their protection. Light must be excluded from the collection, as it fades and changes the colors. Continued exposure to strong light has a surprising effect on many insects, bleaching certain colors completely out. Dust on the specimens can be washed off of the non-scaly or hairy insects with ether or benzine, but from the Lepidoptera it is best to blow it off, blowing from the head down the body. Where the insect becomes greasy dirt adheres very tenaciously, and must be removed with ether or some other grease solvent. It is well before beginning to clean a very dirty insect to first immerse it in warm water, to relax those brittle parts of the body that are liable to be broken off by brushing. To remove grease when it has remained for a long time in the body of an insect is sometimes a very difficult matter, and in some cases the discoloration caused by it will not come out. I treat a very obstinate case, that will not yield to soaking in ether, benzine or chloroform, for several days, as follows: If the subject is a large beetle, break off the abdomen (if a small one simply perforate), dig out the greasy matter from inside of both thorax and abdomen, place the parts in a wide-mouthed bottle or jar; cover with bi-sulphide of carbon; set a broad dish pan, containing several inches of boiling water, on a stove, and in this place the bottle after it has been gradually warmed. As the bi-sulphide boils at a lower temperature than water, the water need only be kept scalding hot. Care must be taken in boiling both bi-sulphide and benzine, as they are very volatile and explosive, and the gas should be allowed to escape from the room. When the grease is all gone and the insect comes out in its normal colors, dry it, glue on the thorax, re-pin and it is again ready for the cabinet. I have cured some very bad cases of rare or unique specimens in this way. The formation of green oxide of copper (verdigris) on the pins and in the body of the insect is another serious defacement, and if allowed to remain, sometimes destroys the specimen. The remedy for this is to first soften the insect by placing it over night in the dampening crock, draw out the pin and drop into a bottle of ether and cork up tight with rubber stopper. Allow it to remain until the grease and oxide are dissolved out; clean off with a soft brush and re-pin. In this section of

the country there are no collections, with one exception, worthy of the name. Much of the very fine material taken by the several collectors, who have collected in this locality, has been destroyed, and the collectors, becoming discouraged, have abandoned the field. A nicely prepared series of insects is "a thing of beauty," an object lesson that educates and serves to familiarize us with these most curious and interesting creatures so important in the economy of nature.

AN ACCOUNT OF THE CHIMPANZEES (*TROGLO-
DYTES NIGER*) AT THE CINCINNATI
ZOOLOGICAL GARDEN.

BY CHARLES DURY.

July 12, 1889, the Garden received, by purchase, a pair (male and female) of these interesting animals. They were not related to each other and were nearly of the same age, then about two and a half years old. Being born of "poor but honest parents," their education up to this time had been considerably neglected. By reason of family likeness, it was suspected that they belonged to the illustrious family of "Rooney," and by this name they have been always known. To teach them good manners, and educate them in the many human-like actions with which they have since entertained and amused the thousands of visitors who have seen them, was the first task of their keepers. Chief of these was to make them eat properly with knife and fork. It took about three months of unceasing work to accomplish this. At first the keepers held their fingers closed on the knife and fork, and all food had to be taken in that way. There was always a disposition to drop the knife and fork and return to primitive methods, cramming in the food with the fingers, like children when learning to eat at table. By constant, patient teaching on the part of the keepers, the use of the knife and fork was acquired. To teach them to drink from a cup, without spilling the liquid was equally difficult. Their favorite drink was sweetened black tea, with an egg beaten into it. They never drank water, always being suspicious that it contained medicine. For breakfast, they took one-half pint each of milk, with soda crackers and bananas. Their dinner consisted of boiled rice (one pint to each) and tea. A nicely roasted pigeon was given to the male; he smelled it and tasted it, but afterward used it for a foot-ball. They never could be induced to eat meat. When honey was spread

on crackers and given to the male, he would lay them down and pound them with his hand, and scatter them over the floor. At first, they ate boiled eggs, but the last two years would not eat them. Beef tea they did not like. They were generally in the best of health. At one period, they frequently took slight colds, and it puzzled the Superintendent to account for the cause. He noticed that when clean straw was brought in (during cold weather) from the outside for their beds, they would take it up in their arms and squeeze it; this seemed to force cold air out of the hollow straws. After the straw was first warmed before putting it in they very rarely took cold. In disposition and temperament they were very different, the male being playful and a tease, the female more amiable and affectionate. When the keeper wished to make things lively in the cage he gave them a beef-bladder inflated with air; this the male would grasp by the fleshy end and take fiendish delight in pounding the female with it, she cowering in the corner and covering herself with straw. When the female did not care to play, the male would tease and try to provoke her into doing so, much after the manner of a mischievous boy. When they were quite small a carpenter at work in the cage dropped his hammer; this was instantly seized by the male, who had been watching him use it. Taking it in both hands he attempted to drive a nail with it. The male walked erect frequently, and the female never did. The male was very fond of children, and was happy when a school visited the Zoo. Both animals were very much frightened at thunder, crouching in the corner in abject terror.* They always drank their own urine when they could get it. When the floor was clear of straw they would get it; afterward, when the straw was put in to prevent this, they hollowed out a dent in the seat of the leather-covered sofa, and used that to secure it. The sofa was then taken out, and they used the table top. The top of the table was then perforated to prevent this disgusting habit, the effect of which was to cause an eruption to break out on their bodies. At one time, when the male was three years old, it was found necessary to treat this eruption with a medicated wash, and it

* A gorilla, mentioned by Hartman, was also so frightened by thunder, and similar noises, as to cause an impairment of digestion.

was found that he was so strong it took four men to hold him before the wash could be applied. The female would spit quite a distance between her closed teeth. The male never learned this trick. The male was very fond of helping the keeper clean the glass with a rag.* Many cockroaches came into the cage, which they never ate, but seemed to be annoyed by them when they crawled over them when asleep. The male slept on his back with his arms thrown over his head; the female slept on her side. Each knew his or her name—"Pat," or "Granny"—when called.

Mr. Stephan thinks they mature at about twelve years of age. At about five years of age they shed their front teeth. It was very dangerous for a stranger to enter the cage. On one occasion the male knocked a workman out completely. Mr. Hostetter the keeper, could do anything with them, though at times they would play tricks on him. A rubber doll was given the male—one of those that emitted a cry when squeezed. This pleased him very much; he sat on it and jumped up and down, but his rough usage soon wore it out. After a few days another one was procured, one that had a knit dress on, but lacked the crying attachment. When this was given him he quickly squeezed it, but failing to hear it cry, turned up its dress, looking at the spot where the first one had the circular crying whistle set in its back, and seeming perplexed and disappointed that this one was not similarly provided.

The first symptoms of the disease, consumption, (that destroyer of caged monkeys†) that carried off the male, was noticed nine months before his death, but he was only observed to cough about three months before. The post-mortem revealed tuberculosis of the left lung, with complete solidification and adhesions. When the male died the female was, apparently, in good health. She seemed to miss the male only for a day, though when he was taken out of the cage, just before his death, she pulled her hair and rolled around in a fearful rage because she could not go also. The

*Dr. Hermes, of Berlin Aquarium, gives an account of a chimpanzee cleaning glass in a similar manner.

†Of more than 200 post-mortems made by me on monkeys from this Garden, since September 19, 1875 (the date of the opening of the Garden), above 75 per cent. have succumbed to tuberculosis.

male was sent East to be stuffed. Soon after the death of the male, the female showed symptoms of tuberculosis also, and she died after an illness of only two months. The post-mortem revealed the right lung completely occupied with a tubercular mass that was firmly adherent to the posterior thoracic wall. Softening of the tubercle had commenced; left lung inflamed and filled with an exudation of frothy fluid; one small tubercular mass in liver; other organs normal. Brain fully developed and perfectly normal; examined about eight hours after death by myself. I have preserved the female, which has been nicely photographed by Mr. T. H. Kelley, Secretary of this Society, who has kindly given us the negatives used for Plate X. When the male was returned mounted, from New York (Rochester), it was found that the facial angle was wrong, the upper lip swelled and projecting, when, in fact, the lower lip projected markedly in both of these animals during life. The face had been also painted entirely black, whereas, the muzzle was flesh-tinted in life. When the stuffed male was placed in front of the cage the female refused to have anything to do with him, and was so annoyed by his presence that it was necessary to screen him from her sight. I was requested by the Superintendent to tint the face flesh color, and had the animal moved in front of the glass door to copy the color from the female, who was lying sick in the cage. When she saw me at work she made a series of unearthly screams, and flew at the door as though she would tear me to pieces, but as the color was applied she became quiet, watching me intently all the while. After this, when I put my face near hers to see the color, she attempted to kiss me, and whenever I went near her up to the time of her death, she behaved in an affectionate and gentle manner, and very different from the way she had acted toward me before.

Such a look of keen inquiry and surprise as shown from her deep brown eyes,* and was expressed on her homely face, I have never seen in any animal other than the genus *Homo*. From the torn hair and scratches inflicted by her on herself,

*Hartman, in his excellent work on Anthropoid Apes, p. 95, Inter. Scientific series, vol. 52, says the iris of the chimpanzee is light brown, verging on yellow. The iris of those under consideration was the darkest of brown, almost black.

her last moments must have been great agony in an effort to draw breath. Many of the foregoing facts have come under my own observation, others have been kindly furnished by Mr. Sol. Stephan, the Superintendent of garden, who has observed their habits so accurately. These animals were in the garden five years, and while all were highly amused by their antics, but few people appreciated how interesting they were from a psychological and zoological point of view. These are the only anthropoid apes ever exhibited by the garden, except a young chimpanzee and young "orang" (*Samia Satyrus**) in 1877.

It may be of interest to repeat the following anatomical points in which these animals most closely resemble man. The "chimpanzee," in the character of its cranium, its dentition and proportional size of its arms. The "orang," in the number of ribs (12 pairs), form of cerebral hemispheres and ossified styloid process. The "gorilla," in the proportions of the leg to the foot and the foot to the hand and cubic capacity of cranium. The average volume of brain in *Troglodytes niger* and *Samia satyrus* is about twenty-six or twenty-seven cubic inches, about half the minimum normal brain of *Homo sapiens*. In *Troglodytes gorilla* the volume of brain rises to near thirty-five cubic inches. Of the *Anthropomorpha*, to which these with the "Gibbons" belong, the "Gibbons" are obviously most remote from man (I quote from Huxley). The strength of the "chimpanzee" is amazing when the bulk and weight of the animal is considered, and they take and require each day a great amount of exercise in captivity when in a healthy condition, a horizontal bar being their favorite sport. They grasp it with hands and feet and whirl around like an acrobat. Any weak or loose place in their cage is quickly discovered by them, and they work at it persistently to enlarge and open it. The spirit of mischief is very strong within them, and in this respect they are strikingly like some children. They have good memory and strong perceptive powers, observing every thing going on around them. Once a spider was brought into their cage with the straw, and the male saw it and was much frightened, clinging to the keeper

*For an excellent account of *Samia Satyrus* see Wallace, "Malay Archipelago," p. 40.

for protection. Afterward the keeper made an artificial spider and moved it with a thread, but the "chimpanzee" instantly detected the fraud. Some of their actions are so very human like, and their vivacity so constant, it makes them the most interesting creatures in the Animal Kingdom. The "chimpanzee" is found in Africa, ranging over a wider extent of country than the "gorilla," and seems to be a much more common animal. The "gorilla" also is a native of Africa, between latitude 2° N. and 5° S. and longitude 6° and 16° E. The "orang" is only found in Borneo and Sumatra,* being much more abundant in Borneo. This animal can stand quite a low temperature; one exhibited at World's Fair, in Java village, was in an open bamboo cage, when it was so cold I was shivering in a heavy overcoat, and yet the "orang" seemed in good health and lively condition. The "Gibbons" are found in India, Burmah, Sumatra and the Malay peninsula, and seem to be much lower in the mental scale, lacking certain features of brain development.

Mr. Doherty, who spent sixteen years in the far East, and closely observed "Gibbons" in India, etc., has recently given me these facts in regard to them. He says, "In Assam, *Hylobates huloch* was very abundant, living along the rivers in swampy tracts. This animal is a lively, active, and most interesting creature; is more monkey-like, and has none of the heavy, stupid ways of the 'orang.' The chorus of 'Gibbons' always waked me up in the morning, when camping in their country. Their habit of singing is as follows: An old male gets high in a tree that has a clear top, where he can be seen by the assembled crowd; with musical, bell-like notes he runs up and down the scale; the balance of the band join in the chorus. The notes are remarkably clear and pure, and the crowd seem filled with wonder and admiration when a very high note is reached."

Mr. Garner, who is endeavoring to demonstrate that a language exists between the monkey tribes, and who says he has studied chimpanzees and gorillas in their native jungles, informs me that all the stuffed specimens of these animals which he has seen are perfect caricatures of the living

*Mr. Doherty saw them in Borneo, but never saw any in Sumatra, and thinks they must be very rare there.

creatures. I have never seen much evidence of any language between monkeys or apes, although I have spent much time in the monkey house at our Zoo observing these animals. It is true, certain vocal sounds are indicative of certain emotions. The spiteful cry of a teased monkey arouses all the others within hearing distance, into action; the satisfied grunt with which one monkey receives a piece of banana or apple starts all into an attitude of expectation, while the sharp cry of alarm from one sends every monkey quickly to a place of safety. Many animals and birds seem to have a language to this extent.



DESCRIPTION OF PLATE VII.

	PAGE.
<i>Orthoceras ludlowense</i> n. sp.,	139

Fig. 1, lateral view of ten chambers, also showing the arching of the chambers; Fig. 2, an end view, showing the eccentric position of the siphuncle.

<i>Gomphoceras indianense</i> n. sp.,	137
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Fig. 3, body chamber and ten septa; Fig. 5, outline of a transverse section; Fig. 4, outline of the tenth septum and position of siphuncle.

THE JOURNAL

- OF THE -

Cincinnati Society of Natural History.

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CINCINNATI, JANUARY, 1895.

NO. 4.

PROCEEDINGS.

September 4, 1894.

The meeting was called to order at 7.52 P. M., with President James in the chair.

Upon motion, the reading of the minutes was dispensed with.

On behalf of the Executive Board, Mr. T. H. Kelley proposed Miss Louise Shaw for life membership, because of her assistance in procuring and donation of mammalian remains found upon her property.

The reading of the Executive Board minutes having been dispensed with, Mr. James outlined the proposed plan for the next meeting. It will be devoted to the mastodon remains found in Hyde Park.

Adjourned at 8.01 P. M.

October 2, 1894.

The meeting was called to order, by President James, at 8.00 P. M.

The reading of the minutes was dispensed with.

There being no proposition for membership, the election of members was declared in order. Upon motion, the Secretary was instructed to cast the ballot of the Society for Miss Louise Shaw as a life member. When said vote was duly cast, Miss Shaw was declared elected.

In view of the papers to be read before the Society, the reading of the Executive Board minutes was dispensed with.

Mr. T. H. Kelley gave notice of the presentation of a constitutional amendment, on behalf of the Executive Board, to Articles III and V of the Constitution, and Section 2 of Article I of the By-Laws, so as to provide for associate members.

Mr. James, the President, then made a few informal remarks upon the recent finds at Hyde Park and Linwood, indicating their value to the Society.

The Director of the Museum, Mr. Seth Hayes, presented a preliminary report upon the mammalian remains found at Hyde Park. He also, in an informal way, called attention to the human skeleton and accompanying relics found within ten days at Linwood.

Professor George W. Harper spoke upon the geology of the locality where the mastodon bones were unearthed.

Dr. M. H. Fletcher gave a most interesting talk upon the development of teeth, and their value in the identification of species. Considerable time was devoted to mastodon and elephant teeth. He employed lantern-slide illustrations.

The President expressed the thanks of the Society to the gentlemen for the three papers, and announced that upon the adjournment of the Society the relics could be studied at leisure.

Being called upon, Dr. O. D. Norton gave some personal reminiscences in obtaining mastodon bones.

Adjourned at 9.39 P. M.

November 13, 1894.

The meeting was called to order by President James at 8.06 P. M.

Minutes of October 2 were read and approved.

The names of Prof. C. G. Lloyd and Miss Mamie B. Walker were proposed for membership.

Mr. Kelley gave second notice that he would propose certain amendments to the Constitution at the next meeting.

Upon motion, the reading of the minutes of the Executive Board was dispensed with.

Written communications being in order, Mr. Charles Dury presented a most instructive and entertaining paper upon the Chimpanzee at the Zoological Gardens.

Dr. B. M. Ricketts followed with some informal remarks concerning his investigation of the comparative anatomy of the feet of the man-like apes.

Mr. Wm. Hubbell Fisher asked Mr. Dury as to the cause of the strength of the chimpanzee. Is it due to the quantity of muscle, contractile power or leverage? Mr. Dury replied that it was due to the contractile power.

In reply to a question from the President, Mr. Dury stated that in life and health they weighed about 75 pounds.

After various remarks, concerning Sandow's marvelous strength, the Society adjourned at 9.23 P. M.

January 8, 1895.

The meeting was called to order at 8.12 P. M. by President James.

The application of Mr. Seth Hayes, for active membership, was presented, and ordered posted.

Upon motion, the Secretary was instructed to cast the ballot of the Society for Prof. C. G. Lloyd and Miss Mamie B. Walker for active members. The ballot was so cast, and they were declared duly elected.

The resignations of Harry F. Woods and Jas. A. Collins were read and accepted.

Mr. Kelley presented the proposed amendments to the Constitution and By-laws, on behalf of the Executive Board, as follows:

Article III to be amended by adding thereto the words "*Seventh, Associate or Club Members,*" so that the article so amended shall read as follows:

ARTICLE III. It shall consist of the following classes of members: First, Patrons; second, Fellows; third, Life members; fourth, Active members; fifth, Honorary members; sixth, Corresponding members; seventh, Associate or Club members."

Article V to be amended by inserting after the words "except honorary" and before the word "members," the words "corresponding and associate or club," so that the article as amended shall read as follows:

ARTICLE V. All members, except Honorary, Corresponding and Associate or Club members, shall be entitled to vote and hold office.

The Committee further recommended the following amendment to Section 2, of Article I, of the By-laws of the Society, to-wit:

Section 2 to be amended by adding to said section, as it now is, the following:

Any Association, Club or Society may, upon the recommendation of the Executive Board, be elected annually to Associate or Club membership in the Society.

Associate or Club members shall have the privileges of the museum, the library, and such use of the building of the Society for their meetings as may be prescribed by the Executive Board.

Every Associate or Club member, as soon as notified of its election, shall pay into the treasury of the Society such *per capita* annual assessment (not less than two dollars for each member of the Association or Club elected) as shall be fixed by the Executive Board. A failure to pay such *per capita* assessment within three months after the same becomes due, shall cause a forfeiture of such membership.

So that said Section 2, of Article I, of the By-laws shall read as follows:

SECTION 2. Honorary members may be selected from persons eminent for their attainments in science, on whom the Society may wish to confer a compliment of respect. Corresponding members shall consist of persons residing at a distance from the city, who may be interested in the study of Natural History, or desirous of promoting the interests of the Society; neither shall be required to pay an initiation fee or make any contribution. The nomination of persons for Honorary or Corresponding members shall be made by the Executive Board to the Society.

Any Association, Club or Society may, upon the recommendation of the Executive Board, be elected annually to Associate or Club membership in the Society.

Associate or Club members shall have the privileges of the museum, the library, and such use of the building of the Society for their meetings as may be prescribed by the Executive Board.

Every Associate or Club member, as soon as notified of its election, shall pay into the treasury of the Society such *per capita* annual assessment (not less than two dollars for each member of the Associa-

tion or Club elected) as shall be fixed by the Executive Board. A failure to pay such *per capita* assessment within three months after the same becomes due shall cause a forfeiture of such membership.

They were taken up article by article and section by section, the action in each case being favorable.

Consequently, Section 2 of Article I, of the By-laws stands amended as proposed, while the amendments to the Constitution must be acted upon favorably at their next presentation.

DONATIONS.

Bladder of Walrus (*Odobænus rosmarus*), by Dr. O. D. Norton.

Swan (*Cygnus columbianus*), by Spring Grove Cemetery.

Barn Owl (*Strix flammea*), by Mr. H. Vorhees.

Nine - banded Armadillo (*Tatusia novemcincta*), by Zoological Garden.

Three Wolf Skins (*Canis lupus*), by Zoological Garden.

Osprey (*Pandion haliaetus*), by Mr. Charles Dury.

Mastodon and Other Mammalian Remains: Three tusks and the tip of a fourth; one entire lower jaw, including two mandibular tusks; a portion of another jaw; two loose mandibular tusks; six teeth, in addition to those contained in the jaws above mentioned; two fragments of premolars; one entire left humerus and part of another, also from the left side (the latter is of small size); one right radius; portion of the superior extremity of an ulna; almost complete set of ankle and toe bones of right front foot; head and neck of left scapula; one right acetabulum (small); body of a right femur; lower extremity of a left femur; two right tibæ (one small); two fibulæ, right and left; ten vertebræ, including an axis and atlas; eight ribs; one molar of *Equus fraternus*, Leidy; one vertebra of *Equus fraternus*, Leidy, by Miss Louise Shaw.

Mound Builder Skeleton and accompanying Relics, by Mr. Thos. B. Punshon.

Portrait of Wm. Harkness, by Dr. O. D. Norton.

Large Piece of Silver Ore, by Mr. Pitts Burt.

Ossified corpus cavernosum from Newfoundland Dog (*Canis extrarius*), by Mr. Seth Hayes.

Bird and Mammalian Skulls: Mole (*Scalops aquaticus*); Chipmunk (*Tamias striatus*); Cat (*Felis domesticus*); Bald Eagle (*Haliaetus leucocephalus*); Turkey (*Meleagris gallopavo*), by Mr. Davis L. James.

CATALOGUE OF THE ODONATA OF OHIO.

PART I.

BY D. S. KELLCOTT, Columbus.

No catalogues or lists of the Dragonflies of Ohio have been published; indeed, these interesting insects have been so utterly neglected by our naturalists, that in the catalogues of the North American species, previously issued, only three species are attributed to this State. These are *Calopteryx maculata*, *Tetragoneura semiaquea*, and *Libellula auripennis*. The collection on which this catalogue is based has been made by myself and my students during the last three years, and it is preserved in the Museum of the Ohio State University. I have not learned of the existence of any considerable collection, public or private, made by others, which I could consult; hence, very few species have been included in this list which I have not myself taken or examined in the fresh condition. Inasmuch as collecting has occupied so short a time, and has been confined largely to the central and northern parts, it has been thought best to publish an account of the species thus far taken as Part I, and to endeavor to explore the southern portions in the near future, publishing the results as Part II.

The number of species, at present, occurring within our bounds appears to compare favorably with that of other regions of the Mississippi Valley of corresponding latitude, viz., 38° 30' to 42° North. While lakes, ponds, and morasses, which are favorable homes for the nymphs of the Odonata, are not numerous, many and copious streams traverse the State, and the great Ohio, the Beautiful River, on the south, and Lake Erie on the north, with its numerous estuaries and sheltered areas of reed-grown waters, compensate for the unfavorable conditions of the State at large. Whether or not

the number of species is decreasing as a consequence of the profound changes due to more complete occupation of the country by civilized man, it is impossible to know. In all probability, the draining of swamps and ponds, the resulting disappearance, in Summer, of former perennial streams, and the contamination of others, will, sooner or later, produce a material reduction.

The common names of the adults are often as striking as the forms themselves. In the central and southern sections they are almost universally known as "snake-feeders;" in the north and northwest, as "spindles;" in the northeast they are often "devil's darning-needles." Still, any one of these, and others, may be heard in any section. Among the less common designations may be mentioned the following: "horse stingers," "mosquito hawks," and "dragon-flies." The last, used more or less everywhere, is, by far, the most desirable. It expresses so aptly and happily the characteristics of these veritable dragons of the air. No insects possess a more pronounced individuality than the Dragon-flies; hence, none appeal more strongly to the imagination. Their graceful forms, brilliant colors, and arrow-like flight at once arrest attention and hold the interest; it is, therefore, not surprising that they have received so many and such poetic names. It has been said that "some of these names testify to the wide-spread, but quite unfounded, belief in the harmfulness of these creatures to man." The writer recalls at least one grown person who truly believed they were harmful. This was a school teacher, who impressed upon him, and others of her charge, that the devil's darning-needles about the "old swimmin' hole" were dangerous, and that they were quite determined to sew up the ears of truants who sought the limpid waters and grass-covered banks of the millrace, rather than the hard and strict ways of the prosy school-room. This is the one "fact" of Natural History he remembers to have been taught him in the "district" school.

In the catalogue a statement of such biological facts as have been observed will be made under the title of each species, together with additional information at hand which it is thought may prove useful for future comparison. Neither bibliography nor synopsis of systematic arrangement is

appended. These matters are included in papers but recently published by Nathan Banks* and Philip P. Calvert†.

The systematic arrangement and nomenclature adopted in this paper are those of Mr. Calvert's paper. The main groups are as follows :

ORDER ODONATA.

I. SUB-ORDER ZYGOPTERA.

I. FAMILY AGRIONIDÆ.

- (1) Sub-family Calopteryginæ.
- (2) Sub-family Agrioninæ.

II. SUB-ORDER ANISOPTERA.

2. FAMILY ÆSCHNIDÆ.

- (3) Sub-family Gomphinæ.
- (4) Sub-family Corduligasterinæ.
- (5) Sub-family Æschninæ.

3. FAMILY LIBELLULIDÆ.

- (6) Sub-family Cordulinæ.
- (7) Sub-family Libellulinæ.

(1) CALOPTERYGINÆ.

I. CALOPTERYX MACULATA Beauv.

This species appears to be found throughout the State, and to be abundant in most localities. It prefers small streams, especially the meadow-brooks and the clear, cool rivulets from springs among the hills of southeastern Ohio. I have taken

* A Synopsis, Catalogue, and Bibliography of the Neuropteroid Insects of Temperate North America. Transactions Am. Ent. Soc., XIX, pp. 327-373, 1893.

† Catalogue of the Odonata of the Vicinity of Philadelphia, with an Introduction to the Study of this Group of Insects. Trans. Am. Ent. Soc., XX, pp. 152-272, 1893.

it at Columbus as early as May 15, and at Sugar Grove as late as September 4. Milan, July 10; Oberlin (Lynds Jones); Mansfield (E. Wilkinson).

In this species, at least, the male does not seize the female with his feet previous to clasping her prothorax with the abdominal appendages. He flits about her, when at rest, gradually approaching, and, finally, the female not attempting to avoid him, he poises himself with sufficient accuracy to pick her up by the prothorax, when they fly away "in couple."

2. CALOPTERYX ÆQUABILIS Say.

Æquabilis is apparently a rare insect throughout a greater part of the State. Dr. Paul Fischer has taken it at Columbus and I have taken it at Sugar Grove, in June. There are no noticeable differences between these Central Ohio specimens and those from Michigan, where I have taken it sparingly. The males agree well with Dr. Hagen's description in *Psyche* V, 246. The single female in the University collection differs by not having a median dorsal abdominal band except on 8, 9, and 10, and by having the "second joint of the antennæ yellow externally" only on the basal half. The pterostigma is not reticulated, longer and narrower than in *Maculata*.

C. AUGUSTIPENNIS Selys, and C. DIMIDIATA Burm. are attributed to Kentucky by Dr. Hagen, and may reasonably be expected to occur on this side of the Ohio River.

3. HETÆRINA AMERICANA Fabr.

A common form in the central parts, probably distributed throughout; at Columbus, Central College, and Sugar Grove, it is abundant along rivers and smaller streams, especially where grasses and shrubs overhang the water rippling over bars of pebbles and among boulders. I have not seen adults until the middle of July, but they are often numerous until the middle of October, and may ordinarily be found as late as the beginning of that month.

Americana, it seems, is peculiarly restricted in its range of flight. I have never observed one so far as a few rods away from their accustomed habitat—the water's edge. Another notable habit is that of congregating, sometimes in companies of hundreds. These assemblies commence in the afternoon, and do not disperse until the warmth of the following day awakens them to activity. Both sexes assemble, and they rest so compactly that I have captured seventy-five by one sweep of the net. The slender, drooping twigs of the willow, loaded with these beautiful insects, like a string of gems, present a beautiful picture.

I can not think that the female of this *Hetærina* "flirts her eggs into the open river, without attaching them to aquatic plants."* It is not unusual to capture those having the last few joints covered with mud precisely as is often the case with endophytic species. In a few instances I have seen the female, unattended by the male, resting on a half-submerged log, or algal-laden rock, or water-weed, and thrusting the abdomen beneath the water, place her eggs, one by one, in the soft substance.

"The small but distinct tubercle above on the posterior base of the median lameliform tooth of the appendages" is really double, and the truncated tips of the inferior appendages have *two* robust acute teeth directed inward at the median angle of the truncation, instead of *one*, as has been stated. Again, the pterostigma of the female and teneral male is yellow, but that of the adult male is brown or black.

I think we may reasonably expect to find within our limits, most likely along the Ohio River, *H. tricolor* Burm., *H. sclerata* Walsh, and *H. limbata* Selys.

(2) AGRIONINÆ.

4. LESTES UNGUICULATA Hagen.

Taken abundantly at Sandusky, July 3-13, 1894; Milan, July 10; Castalia, July 11; Toledo, August 1. Not uncommon from June to September at Columbus.

* Walsh, Proc. Ent. Soc., Phil. II, 232.

5. *LESTES UNCATA* Kirby.

Sandy Beach, near Lakeside, July 4; Cedar Point (Sandusky), July 12, not uncommon; Oberlin (Lynds Jones). At Corunna, Mich., I found *Uncata* next to *Rectangularis*, the most abundant *Lestes*, from July 15 to August 15, 1894.

6. *LESTES DISJUNCTA* Selys.

A few examples have been taken at Columbus in August; several at Cedar Point June 30, and others at Sandy Beach July 9.

The copulation of different species of Odonata or, at least, the prolonged flight of a male of one species united with the female of another, has been noticed from time to time by observers. At the place and date last mentioned, I took such a couple, consisting of a male *Disjuncta* and a female of *Vigilax*. The disparity in size made the combination quite striking.*

7. *LESTES FORCIPATA* Ramb.

Taken at Cedar Point (Sandusky), June 30, 1894, by William E. Kellicott. Not yet found in any abundance.

8. *LESTES RECTANGULARIS* Say.

This is, by far, our most abundant and wide-spread *Lestes*. I have taken it from June 16 to September 15 at Columbus.

I once saw a female resting on a bullrush, just above the water, when a male approached she quickly slipped down the plant beneath the water, where she remained for perhaps a minute. The male did not follow her.

9. *LESTES VIGILAX* Selys.

This fine species has been taken, thus far, at one station only. At Sandy Beach, July 4 and 9, 1894, it was very abun-

* For a still more heterogeneous union see under *Enallagma civile*.

dant about the borders of a shallow, almost land-locked bay, in which *Nymphæa*, *Sagittaria*, and *Scirpus* were luxuriant. In the early part of the day the sexes were taken among these aquatics, by wading out a distance from shore. In the afternoon of the same day many, especially females, were captured in an open forest along the bank of the lagoon mentioned.

The adult female may be described, briefly, as follows: Length of abdomen, 37 mm.; of inferior wing, 26-28 mm.; width of head, 5 mm. Pterostigma yellowish-brown, covering two and one-half to three cells; post-cubitals on the anterior wings, four and one-half. The head is metallic green in young examples, dark to black and pruinose in old ones, pruinose in the rear; labium, gena, and labrum yellowish, the last two not olivaceous, as in the male; all brownish in dried specimens. Thorax, dorsally, metallic green with mid-dorsal line and a narrow humeral stripe yellowish; sides below and venter yellowish, pruinose in mature ones, above green to the base of hind wings; coxæ, trochanters, and femora inwardly yellow; tibiæ and tarsi black. Abdomen, dorsally, metallic green with mid-dorsal line more or less distinct on 2-4; narrow basal yellow rings scarcely interrupted on 2-7; sides yellowish; sternum blackish, pruinose with age; 10 yellowish, with a rounded sinus in the posterior dorsal edge, its angles marked by a cluster of three or four teeth; appendages more than half as long as 10, pointed, bright yellow; valves black at base, yellowish apically; serrate, valvular spines black, varying much in color with age.

10. *LESTES INEQUALIS* Walsh.

Sandy Beach, July 4. Rare. Taken in the same situations as *L. vigilax*, which it superficially resembles. The males are, of course, readily separated by the slender inferior appendages, which are longer, in *Inequalis*, than the superiors; the females are also easily distinguished as follows: Rear of head of *Inequalis* yellow, of *Vigilax* dark; the pterostigma is darker in the former and covers only two cells or a little more, in the latter two and a half to three; the mid-dorsal

and humeral stripes are narrower and darker; the tibiæ yellow posteriorly instead of black; the valves are darker, relatively narrower and more hairy, the appendages are slightly longer, stouter and darker, and the excavation in the dorso-caudal edge of 10 has a row of ten or more comb-like teeth at its angles, in *Vigilax* there is a cluster of a few only. *Inequalis* is stouter.

Oviposition appears to be conducted in a similar manner by all our species. The females prefer to cling to upright aquatics growing along the borders of sluggish streams or ponds, where they may be concealed by the luxuriance of the herbage, while they place their eggs in the stems below water. That some of them, at least occasionally, descend beneath the water, perhaps to the ooze at the bottom, for this purpose, is pretty well established. The females of *Vigilax* and *Inequalis* are often taken with body and wings covered with silt; it would seem that to immerse themselves in water and mud is with them a habit.

The remaining species of *Lestes* that are most surely regional are *L. eurina* and *L. congener*.

II. ARGIA PUTRIDA Hagen.

It appears to be common everywhere. Along the shores of Lake Erie and on the "Islands," in June and July, there are immense numbers. Green Island is a small block of glaciated, drift-covered rock, a few feet above the blue waters of Erie; it is several miles from the main land and three or more distant from the larger South Bass and Rattlesnake Islands; and yet here, away out at sea, July 5, I found *Putrida*, many just drying their wings, as abundant as about the borders of the sheltered waters of the "Peninsula." It seems a safe conclusion that its nymphs must live in comparatively deep water of the lake or cling to the algæ of the wave-beaten rocks surrounding these isolated knobs. No other species were taken on this island, although several were common on South Bass the same day.

Its seasonal range I have noted as follows: May 17, Clintonville; September 26, Blendon.

12. ARGIA VIOLACEA Hagen.

Columbus, June 8 to September; Milan, July 10; Castalia, July 11. Common.

I have seen a half dozen, or more, females ovipositing at one time in the algæ and sediment on a half-submerged boulder, each with a male clasping her prothorax, and standing straight up to avoid the possibility of contact with the water. Both ludicrous and interesting.

13. ARGIA TIBIALIS Rambur.

I have nowhere seen this *Argia* abundant. June 2, 1894, three males and as many females were taken along the gorge of the Licking River, near Black Hand.

14. ARGIA APICALIS Say.

Taken in abundance at Milan, along the Huron River, July 10.

15. ARGIA SEDULA Hagen.

Many males and three females captured at Sugar Grove, September 4, 1894. They were most numerous in an abandoned lock of the Hocking Canal, through which a small thread of water was flowing. It has heretofore been reported from Virginia and Texas.

The deep black and Prussian blue of the adult males make a striking and beautiful form. The females, on the other hand, are obscure; their color is pale yellowish-olive, inclining to brown on the abdomen; the mid-dorsal carina is black, a pale stripe each side, then darker to and including the humeral suture; the sides of the thorax are pale, the first lateral suture black above, the second wholly so; there is also a blackish line near the posterior border of the mes- and the metepimera. Wings slightly flavescent.

Male abdomen 27 mm., hind wing 18 mm.; abdomen of the female 25 mm., hind wing 20 mm.

There are at least two more species of *Argia* likely to occur in the State, which have not been found as yet, viz., *A. bipunctulata* and *A. fumipennis*.

16. NEHALENNIA IRENE Hagen.

This elegant species was taken at Sandusky, June 26, by W. E. Kellicott. It was common at Castalia, July 11. Many were taken ovipositing among water-crowfoot and algæ, in ditches, where the water was kept at a constant level by the famous spring. Milan, July 10.

17. NEHALENNIA POSITA Hagen.

Columbus, April 23 (Paul Fischer); Sugar Grove, September 4; Milan, July 10; Oberlin (Lynds Jones).

18. AMPHIAGRION SAUCIUM Burm.

Numbers taken near a rivulet of cool spring water at South Columbus, June 16; at Castalia, July 11, not uncommon; Oberlin (Lynds Jones).

I have taken an occasional female much larger than average size. They are always mingled with the ordinary forms, and not otherwise separable. I have not met this peculiarity so strongly marked in any other species.

19. ENALLAGMA CIVILE Hagen.

Common at Sandusky in June and July: Licking Reservoir, July 26; Toledo, August 15; Oberlin (Lynds Jones).

Under *Lestes disjuncta* I have referred to a heterogeneous union, viz., the male of *Disjuncta* and the female of *L. vigilax*; a still more unexpected combination noticed was between the male *Civile* and the female of *Argia putrida*. Both pairs were captured, and are now in the collection.

20. ENALLAGMA EBRIUM Hagen.

Very abundant at Sandusky from June 23 to July 13, 1894.

21. ENALLAGMA DIVAGANS Selys.

Sandusky, June 26, one male; Licking Reservoir, July 25, not uncommon; Sugar Grove, September 4, many pairs taken.

The dorsal band on the second abdominal ring is subject to wide variation. Among twenty males taken in one day, only two had the band for the entire length; the same number had it reduced to a large apical spot, while the remainder varied between these extremes; in a majority it covered two-thirds or three-fourths of the length. There are other interesting variations in its markings, *e. g.*, the humeral stripes are sometimes reduced to exclamation marks, as in *N. posita*, the blue on sides of 2 and 3, the number and width and amount of interruption of the apical rings on 3-6, the postcubitals vary from 7 to 9.

The female, it appears, has not been described. The descriptions heretofore published refer to one of the forms of *E. exulans*. The following brief diagnosis may serve to distinguish the female from others of the genus: Length of abdomen, 18-20 mm.; hind wing, 14-16 mm. The male has the labrum, anteclypeus, genæ, and frons blue, the postclypeus black. The female differs by having the parts that are blue in the male pale to brownish, rest of the head as in the male, *i. e.*, black, with cuneiform, post-ocular spots blue. Thorax black, broad blue stripe each side. The mid-dorsal carina black, the blue stripe not divided by red; sides blue, second suture black; femora and tibiæ black without, pale within, the hind tibiæ with a black line only. Abdomen pale on the sides, with the sternal membrane black, dorsum black, with interrupted apical rings from 3-7; there is a *large, oval, apical, blue spot on each side of 8*, the two separated by a narrow black dorsal line; 10 is black.

In its habits of flight *Divagans* differs from others of the genus. I have never found a female, and but rarely a male, resting upon or flying about the herbage at a distance from the water. From 10 A. M. to late in the afternoon of favorable days they may be found pairing and ovipositing, always flying low and resting on floating plants, such as *Nymphæa*, *Potamogeton*, or *Algæ*. It is not often that the female may be seen ovipositing unattended.

22. ENALLAGMA EXSULANS Hagen.

Columbus, May 12 to September 4; Sandusky, Sugar Grove, Toledo, Oberlin (Lynds Jones). Our most abundant *Enallagma*.

The coloration of the male is more nearly constant than in *Divagans*; the markings of the female, on the contrary, vary considerably, especially the black on the dorsum of 9. The spot is either forked or solid; in one it may extend the whole length of the ring, in others occupy only the apical third or fourth. Fifty pairs were captured, and the nature of the mark on 9 noted. On thirty-four it was forked, on sixteen solid. So, it appears the variety that has been taken for the female of *Divagans* is really the normal form of *exsulans*.

23. ENALLAGMA SIGNATUM Hagen.

Abundant at Sandusky in June and July; Licking Reservoir, July; Sugar Grove, September 4; Oberlin (Lynds Jones).

The immature insects are light blue, the adults brownish orange.

24. ENALLAGMA POLLUTUM Hagen.

Sandy Beach, near Lakeside, July 9, in large numbers; Licking Reservoir, July 25, not uncommon.

The change of color from blue to orange is very similar to that of *Signatum*. There is little difficulty in separating the females of *Pollutum* from those of *Signatum*. Those of the former are a little larger and relatively slenderer; the mid-dorsal thoracic, black band is narrower and the humeral stripe is practically wanting, as there is only a faint brownish suffusion over the humeral suture. The species is of a lighter orange than *Signatum*.

25. ENALLAGMA FISCHERI n. s.

Columbus, May and June; Sandusky, June and July; Oberlin (Lynds Jones). Not uncommon.

Length of abdomen ♂ ♀ 24 mm.; hind wing, ♂ 17 mm.; ♀ 19 mm.

Male.—Labrum, anteclypeus, genæ and frons orange; the labrum has three black points at base; vertex, occiput, upper part of eyes and antennæ black; cuneiform post-oculars connected and greenish-blue; head below pale yellow. The prothorax is black above, with orange, as follows: Anterior lobe with a broad transverse line, middle lobe with a geminate spot in the center and a larger spatulate one each side, the posterior lobe with three small spots, below and on sides pale orange. The "thorax" bronze-black with dorsal carina (sometimes only anteriorly) and humeral stripe bright orange; the legs yellow, with a black line on the outside of the femora and tibiæ (these lines are lightest on the hind pair). The wings are hyaline, pterostigma small, reddish-brown. The abdomen is slender, dorsum of 1-8 and 10 bronze-black, 9 blue, sides and below yellowish-green anteriorly and bluish posteriorly; the tenth segment is prolonged and bifid to about the same extent as in *Enallagma exsulans*; the superior anal appendages are one-fourth shorter than 10, black, bifid, the upper branches divaricate, curved inward and bearing a minute hook at the inner distal angle; the inferior branches are stouter, shorter, obtuse, converging with a slight curve outward; the inferior appendages are yellow, tips blackish, they turn outward and upward so that the tips rest in the forks of the superiors.

Female.—Head as in the male, except that the colors are less vivid; prothorax and thorax are similar, except the mid-dorsal carina is more strongly marked with yellow, pterostigma lighter; abdominal dorsum is wholly bronze-black, although somewhat narrowed on 1, 2, 9, and 10, below greenish-yellow, ventral spine on 8 prominent, valves yellow.

This form was first taken and studied at Columbus, by Dr. Paul Fischer, for whom I propose the name.

The *redressé* tenth abdominal segment and the male anal appendages ally it to *Ischnura*, but the pterostigma is precisely the same on all wings, and the females are not dimorphic, so, while it agrees with *I. curvula* somewhat, I prefer to regard it as *Enallagma*, *i. e.*, differing from the typical forms in the same way that *Exsulans* does. As regards its place

in *Enallagma* it appears to stand in the scheme of Baron de Selys with *E. signatum* and *E. pollutum*; on the other hand, I have taken more than one *Exsulans* with the dorsum of 8 all black, and 9 blue, which coloration would bring *Signatum*, *Pollutum*, *Exsulans*, and *Fischeri* in the same group.

It will be a disappointment if most of the following species do not eventually turn up among our "spindles," viz.: *Annexum*, *Aspersum*, *Durum*, *Hageni*, and *Traviatum*.

26. ISCHNURA VERTICALIS Say.

Very common in all parts visited. The orange females appear to be about one-fourth as numerous as the black variety. It is one of the earliest species on the wing, and one of the last to disappear in autumn. Its range for a favorable season at Columbus is from April 20 to October 10.

I. Ramburii Selys, although a coastwise species, occurs in Ontario, and may yet appear on this side of the great lake. Likewise *Anomalagrion hastatum* inhabiting Indiana undoubtedly occurs in this State. I shall expect to find it at Grand Reservoir.

(3). GOMPHINÆ.

27. HAGENIUS BREVISTYLUS Selys.

Columbus, June and July. Toledo, August 1. I have nowhere in Ohio found *H. brevistylus* abundant; in central Michigan (Corunna) it is next to *D. spinosus*, the most common Gomphid.

Omphiogomphus rupinsulensis and *Tachopteryx thoreyi* are both regional, but not yet taken.

28. GOMPHUS VASTUS Walsh.

Common at Sandusky in July, 1894.

They were taken most freely in an open grove of second growth oak and hickory on Johnson's Island. Many pairs were taken resting on the hanging branches of these small trees. South Bass Island, July 5.

29. *GOMPHUS GRASLINELLUS* Walsh.

Two males taken at Columbus by Dr. Paul Fischer. One of these has been lost, the other is in the University collection; there is also one female, locality unknown, contributed by Dr. Fischer. Thus far this Gomphid has been reported only from Illinois.

30. *GOMPHUS FRATERNUS* Say.

Columbus; Sandusky, where it was common in July, 1894.

31. *GOMPHUS VILLOSIPES* Selys.

Taken at Sandusky, June 26, by W. E. Kellicott. Rare.

32. *GOMPHUS SPICATUS* Selys.

Sandusky, June. Not common.

33. *GOMPHUS EXILIS* Selys.

Lockbourne, July 2. One male.

34. *GOMPHUS SPINICEPS* Walsh.

Sugar Grove, September 4. They were taken late in the afternoon, flying about and ovipositing in a small brook that was rippling over pebbles. They continued to fly until it became so dark that I could not follow them. Pairs at rest; the female oviposits in a manner similar to that of the *Libellulas*. Four were captured, many more were seen.

Male.—Length of abdomen, 48 mm.; of hind wing, 36 mm. The head is blackish-brown, with an olive band on the postfrons. On the vertex there is a U-shaped elevation, the upper angles of which are tooth-like, and between this and the eye on either side there is a small yellowish spine; occiput nearly straight, olivaceous above.

The thorax has the dorsum dark brown with a mesothoracic collar, a short, broad stripe each side and an ante-humeral ray, spatulate above, olive; sides paler, with an olivaceous stripe beneath each wing, olivaceous below; wings hyaline, veins and costa black, pterostigma reddish-brown, 5 mm. long; membranule very narrow, whitish; legs black.

Abdomen black, 8 and 9 strongly dilated, 9 almost as long as 8+10; 1, 2, 8 and 9 olivaceous on the sides, 1-8 with dorsal yellow spots as follows: 1, apical, triangular; 2, lanceolate, nearly the entire length; 3, 4, 5 and 6, basal, oblong; 7 and 8, basal triangular; appendages black, divaricate, superior, longer than 10, acute, depressed, slightly turned up at apex and having eight or ten minute crenulations on the lower outer edge apically, inferior not quite so long, hamulate at apex.

35. DROMOGOMPHUS SPINOSUS Selys.

Columbus, along the Scioto and Olentangy rivers (Paul Fischer). It appears not to be common, at least in central Ohio. In central Michigan, from July 15 to August 1, I have found it common.

The female was several times noticed ovipositing in a manner similar to *Macromia illinoensis*, that is, by skimming the water and every few feet or rods touching the water with the abdominal tip without scarcely checking her speed; at other times I have seen them drop down from an overhanging tree and repeatedly tap the water, remaining in one place after the manner of *Libellula*. Pairs were noticed to fly up into tree tops and remain in union for a considerable time.

36. DROMOGOMPHUS SPOLIATUS Selys.

Toledo, July 31, 1894, two males were seen and one of them captured; they were flying among the phenomenal stretches of *Nelumbium* of the Maumee.

The occurrence of this species in Ohio, hitherto reported only from Texas, was a gratifying surprise. I at first supposed it was *D. armatus* (Georgia), but it appears to be *Spoliatus*, for reasons as follows: 1. The face is wholly yel-

low, *i. e.*, it wants the black transverse line between the frons and clypeus which is present in *Armatus* (head yellow, front with a transverse black line inferiorly — Hagen). 2. The appendages are clear yellow, brown in the other. 3. The ornamentation appears to agree better throughout with *Spoliatus*, as described. 4. The oblique lines on side of thorax are isolated.

The last four rings are colored as follows: 7, sordid olive; 8 and 9, reddish-yellow, clouded with darker shades. The tarsi and tibiæ are black, femora blackish beneath, yellowish above; hind pair with dark line laterally for nearly the whole length, otherwise yellowish on proximal two-thirds, blackish distally.

Length of abdomen, 45 mm.; of hind wing, 36 mm.

The Gomphids are but poorly represented in the collection; when all are known the number will doubtless be doubled.

(4). CORDULIGASTERINÆ.

37. CORDULIGASTER ERRONEUS Hagen.

Sugar Grove, July 5, resting above a cold spring on a hill side.

(5). ÆSCHNINÆ.

38. EPIÆSCHNA HEROS Fabr.

Columbus, June 4; Oberlin (Lynds Jones), Mansfield (E. Wilkinson).

This spindle often flies into buildings through open doors and windows; of course, others do so occasionally, apparently by accident; this one from choice.

39. FONSCOLOMBIA VINOSA Say.

Rare. Taken by Mr. E. E. Bogue, at Orwell, in September. I have taken this species in Michigan in August.

40. *BASIÆSCHNA JANATA* Say.

Central College, May 28; Sugar Grove, May 30. In both cases they were just issuing from small, rapid streams among precipitous hills.

41. *ÆSCHNA VERTICALIS* Hagen.

Columbus, September and October, flying with *Æ. constricta*. Only males distinguished.

42. *ÆSCHNA CLEPSYDRA* Say.

Oberlin, attested by Mr. Lynds Jones. I have not taken it in the State, but have done so in central Michigan.

43. *ÆSCHNA CONSTRICTA* Say.

Occurs wherever I have collected in the State. Common in September and in October, until after killing frosts.

44. *ANAX JUNIUS* Drury.

Common throughout the State. It is the first dragonfly abroad in early Spring, and remains with us until the middle of October. This year (1894), it was plentiful along an old river bed on the State University grounds, on March 21. Several pairs were seen on this date, flying about in union, ovipositing. In this case, the pair rested low down on old *Typha* stalks, while the eggs were placed in the soft tissues beneath the water. On March 23 it turned cold, and remained so until April 15. On the 16th, *Anax* was again abroad, apparently uninjured by frost, ice and snow of the preceding three weeks.

I have many times noted the males flying their usual beats until so late in the evening that they were scarcely discernible in the faint twilight.

Dr. Paul Fischer has pointed out an instance happening in Columbus, which appears to show that in this species, at least, imagos mature from eggs laid the same season.* An excavation for a "lake" in Franklin Park was made, where formerly there had been no water, during the Winter. Early in May the lake was filled from the water works pipes; late in August large numbers of *Anax junius* crawled out of their nymph cases along the banks of the lake. Dragonfly nymphs are rarely seen in the water supply.

45. *MACROMIA TÆNIOLATA* Ramb.

Toledo, July 31, 1894. Not uncommon along the Maumee, above the city. I found it much more difficult to approach and capture than the next.

46. *MACROMIA ILLINOIENSIS* Walsh.

Columbus, Sandusky, Toledo, Georgesville. About Sandusky Harbor and on Johnson's Island, in July, they were common, especially so, flying in an open wood; many pairs were seen at rest high up among the foliage.

This species prefers to remain about streams flowing over rocks and pebbles. The female oviposits in such places, and may be seen skimming the surface, scarcely distinguishable from the male by her flight, save as she now and again touches the water to deposit her eggs.

Didymops transversa Say. is surely quite regional. It is known in Michigan and in Kentucky. It remains to be taken.

(6.) CORDULINÆ.

47. *EPICORDULIA PRINCEPS* Hagen.

Throughout the State. Common. From nymphs.

48. *TETRAGONURIA CYNOSURA* Say.

Columbus, from nymphs. Ohio (Hagen).

* Ent. News, Vol. II, 179.

(7.) LIBELLULINÆ.

49. PANTALA FLAVESCENS Fabr.

Columbus, September (Paul Fischer); October 6, 1894 (F. L. Landacre).

50. TRAMEA CAROLINA Linné.

Columbus, September 6; Sugar Grove, September 4.

51. TRAMEA LACERATA Hagen.

Sandusky, June 26 to July 15, 1894.

On Catawba Island, July 5, it was found in numbers about a stream, the mouth of which was choked by a bar of pebbles washed up by the lake. Aquatics were abundant inside the shelter, where the water was kept at a constant level by currents through the bar.

52. LIBELLULA BASALIS Say.

Our most abundant species of the genus. At Columbus, from May 15 to September. On one occasion, at Sugar Grove, it was plentiful, and a majority of those taken had the tips of all the wings strongly infuscated.

53. LIBELLULA AURIPENNIS Burm.

Ohio (Hagen). It must be everywhere rare; I have seen only one in the State.

54. LIBELLULA QUADRIMACULATA Linné.

Columbus (Paul Fischer). Rare.

55. LIBELLULA SEMIFASCIATA Burm.

Columbus, June. Not common.

56. LIBELLULA PULCHELLA Drury.

Abundant in all parts. At Columbus from June to September 15.

There are a few regional species not yet in hand, *e. g.*, *Intacta*, occurs in Central Michigan; *Exusta*, it is supposed, was seen by W. E. Kellicott in Franklin Park; it could not be taken, as the police appeared at the same time.

57. PLATHEMIS TRIMACULATA De Geer.

Common in all parts explored. Columbus from May 6 to September.

CELITHEMIS.

58. CELITHEMIS EPONINA Drury.

Very abundant at Licking Reservoir, July 20; Ottawa River, August 1. Taken also at Sandusky, Lancaster, and Oberlin (Lynds Jones).

59. LEUCORHINIA INTACTA Hagen.

Very generally distributed, and usually abundant. In Woodlawn Cemetery, Chicago, June 25, 1893, I found this form literally in swarms about the "lakes." It was not in accordance with the wishes of those in charge that an insect net should be used to take them, so I resorted to "hand-picking," and readily secured a dozen pairs, as they rested on the shrubbery.

60. DIPLAX RUBICUNDULA Say.

Everywhere abundant.

At Columbus from June 8 to October 7.

61. DIPLAX ASSIMILATA Uhler.

Not uncommon at Columbus in August and September. Toledo, August 1.

At the latter place it was issuing in plenty, and was by far the most common *Diplax* seen about the marshes at the date mentioned.

62. *DIPLAX COSTIFERA* Hagen.

Columbus, October 7; very few examples have been taken, and there is some uncertainty about the identification, as the specimens were somewhat worn. It is clearly different from others of this list.

63. *DIPLAX OBTRUSA* Hagen.

This appears to be as widespread and as abundant as *Rubicundula*. It is a little smaller than that species, the front much whiter in the males and somewhat so in the females. The females of the two species are difficult to separate.

64. *DIPLAX SEMICINCTA* Say.

Columbus, June 17 (W. E. Kellicott); Sandusky, common in July.

65. *DIPLAX VICINA* Hagen.

Very abundant at Columbus; taken also at Sandusky and Licking Reservoir.

It appears not to issue as early as the other species, but is abroad later. I have taken it ovipositing November 7; Mr. E. E. Bogue has taken it November 8.

66. *PERITHEMIS DOMITIA* Drury.

Common, Columbus, May and June; Lockbourne, July; Sandusky, June and July; Sugar Grove, September 4.

67. *MESOTHEMIS SIMPLICOLLIS* Say.

Abundant throughout the State; seen from May to September.

68. *PACHYDIPLAX LONGIPENNIS* Burm.

Common in all parts.

THE SHAW MASTODON.

AN EXAMINATION AND DESCRIPTION OF MASTODON AND
ACCOMPANYING MAMMALIAN REMAINS FOUND
NEAR CINCINNATI, JUNE, 1894.

BY SETH HAYES,

Museum Director of Cincinnati Society of Natural History.

On June 4, 1894, some Italian laborers were sinking a cistern upon the property of Miss Louise Shaw, in Hyde Park, near Cincinnati. They threw out some fragmentary bones and pieces of tusks, which were incentives for an extended and careful search, that has resulted in adding valuable material to the already extensive collections of the Cincinnati Society of Natural History.

The first fragments reached the Society by means of a student in one of the Cincinnati High Schools, having been sent by Prof. George W. Harper. The Museum Director, in company with another officer of the Society, visited the site of the cistern. By permission of Miss Shaw, the writer descended to the bottom of the fourteen-foot cistern and, by means of a little undermining, recovered a finely preserved tibia. After a careful study of the fragments already brought to light, and a survey of the location, the writer was convinced that more material could be snatched from mother earth, which would, in all probability, be of greater value than the specimens already found. Miss Shaw having given her willing consent for further excavations, the matter was referred to the Executive Board, with the Director's recommendation, who, in turn, instructed him to do as he thought best, although they were of the almost unanimous opinion that nothing would be found. As a consequence, work was commenced upon the second and largest shaft July 10.* Its

*The cistern is considered by this paper as the first shaft.

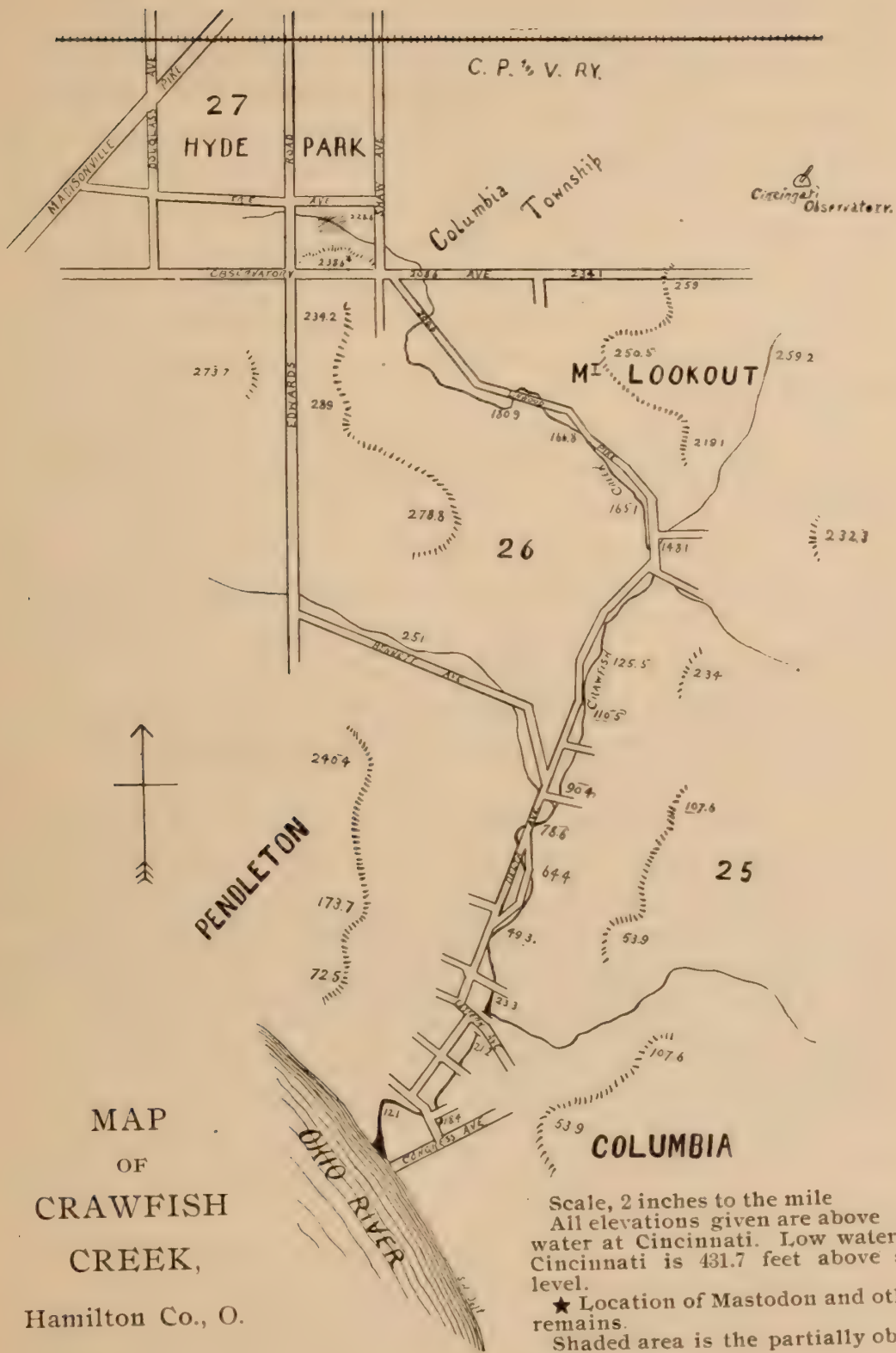
location and dimensions were particularly fortunate, as it was from it that the bulk of the find was procured. Almost three weeks were consumed in making this one excavation. That the work was very slow, and difficult as slow, can be judged by the quantity of bones that were so promiscuously and closely buried in this shaft. After a depth of five feet six inches had been reached the task became very laborious and tedious. From this depth to twelve feet seven inches, only one helper could be advantageously employed, and the work was virtually done by the use of trowels, while around the more closely-wedged bones, nothing but the bare hands would answer. All signs of remnants having ceased at a depth of twelve feet seven inches, soundings were made by means of tunnels, in all directions, on a horizontal line, and by smaller shafts to an extreme depth of twenty-one feet six inches.

The third and fourth shafts were sunk to a depth of fourteen feet. The third only produced two fragments of teeth, that were evidently from the premolars of a very young *M. americanus*, while the fourth was entirely barren.

The location of the find is in Section 27, of Columbia Township, just north of Observatory Avenue, and west of Shaw Avenue, thus being but a few yards outside of the limits of the City of Cincinnati,* and on the brow of a small but abrupt knoll, which, at this point, runs almost due east and west, 670.3 feet above the sea level. To the North, at the base of the slope, are the remains of a swamp. At present only a very small area is covered by marshy ground, as compared with its original extent. The swampy ground is ten feet lower than the surface level of the shafts. The springs abounding in this mire are the principal sources from which Crawfish Creek arises. This creek, which is a direct tributary to the Ohio, flows first to the southeast and then to the southwest by south, flowing into the Ohio two miles south of the swamp.

The territory, which is drained by the creek, although of only moderate area, was formerly very rugged, and, as the map will indicate, is even yet marked in its sudden changes of elevation, in spite of its being in the heart of a great city.

* See map. At point indicated by an asterisk.



It is still doubtful to what period the formations belong. The yellow clay is unquestionably of post-glacial origin, while the boulder-clay (Hard Pan) is as certainly glacial. They both contained small fragments of carbonized wood and rare traces of vegetable matter. The yellow clay, which was rather uniform, extended to a depth of five feet eight inches, where it graduated somewhat unevenly into the blue clay, which had an average depth of seven feet three inches. The blue clay passed gradually from a smooth even consistency above, through all the intermediate stages, to a decidedly gravelly condition below. Sand was found at different depths and of different kinds, in each instance being a clearly marked pocket of greater or less extent. Yellow sand was only found in the north-west corner of the second shaft and in one large pocket. The bones that were in contact with it were very badly decayed. The other sand pockets contained a rather uniform fresh-water sand. In two instances, however, the sand contained numerous minute shells with a quantity of fragments.* In these cases the surrounding clay, particularly that above, contained similar mollusks.

The peculiarity of the horizon was so perplexing that Dr. Edward Orton was requested to visit the diggings and assist in reaching some decision.

This decision hinged entirely upon the relation of the blue clay to the remains. If all or even a good portion of the clay had been above the bones, they naturally would have been termed inter- or even preglacial. But as it is, it is a much more difficult problem. The bones reached to the bottom of, and, at least once, below the boulder-clay; while the latter did not entirely cover them, for a few small fragments were found in the yellow clay, and, in one instance, a tusk, which at its base rested at the bottom of the blue clay, pierced the latter and penetrated the overlying yellow clay for a short distance with its tip.

It seems as if the Hard Pan was either deposited after or during the heaping up of the bones from the neighboring swamp. The evidence being somewhat questionable and contrary to all former discoveries of mastodon and mammoth

**Physa aricillaria*, Say; *Planorbis* (*Gyraulus*) *parvus*, Say; and *Anculosa costata*, Anth. were present in abundance, but of a small size.

remains in Ohio, Dr. Orton has thought best to place it among the post-glacial finds.*

Heretofore, such mastodon bones as have been found in Hamilton County have been mere fragments or, at best, only an odd bone or two, always accompanied by, and usually resting upon, washed gravel. But, in this instance, we have a quantity of bones, from at least three mastodons. So that, locally, this find, from quantity alone, is a justly notable one. The fact of more than one animal being represented is of more than passing significance. Although there is no reason to suppose that these animals were mired, or that they floated to their last resting place entire—since the bones were so scattered and out of their relative positions—yet, they must have perished in the immediate vicinity—probably in the neighboring swamp—and during different freshets were carried into an eddy along the bank and deposited from time to time where they were unearthed.

The following list indicates the principal bones recovered, they belong to *M. americanus*, unless otherwise indicated, to-wit:

Three tusks and the tip of a fourth.

One entire lower jaw, including two mandibular tusks.

(See plates XI and XII.)

*Dr. Orton's report is as follows:

COLUMBUS, OHIO, December 10, 1894.

MY DEAR MR. HAYES:

At your request I visited the locality in Hyde Park from which were taken the interesting mammalian—mainly mastodon—remains that you secured for your Society last Summer. I noted as far as possible the geological facts of their occurrence. From what I saw and from the information you gave me, I am of the opinion that the mastodon remains are of post-glacial origin or age.

There were some anomalous facts connected with them that made me halt for a time between two opinions as to their date, viz: whether they were *post-glacial* or *inter-glacial*; but, on the whole, I felt constrained to adopt the conclusion above expressed. This conclusion is in line with all the other discoveries of mastodon and mammoth remains in Ohio with which I am acquainted; indeed, I have never met a case before in which any question could be raised.

You report your "find" as occurring in blue clay. Above the blue clay is yellow clay and sand, with a few molluscan shells of living species. This last division is unmistakably *post-glacial*. Below the remains there are a number of feet of equally unmistakable *boulder clay*. The question is as to the age of the deposit that covers the bones, whether it belongs to the upper or lower series. I have given the answer that seems, on the whole, best supported, when I reported the bones as found in a post-glacial formation.

I congratulate the Society on the very interesting discovery, and I do not see how your part of the work could have been better done.

Very truly yours,

EDWARD ORTON.

A portion of another jaw.
 Two loose mandibular tusks.
 Six teeth, in addition to those contained in the jaws above mentioned.
 Two fragments of premolars.
 One entire left humerus and part of another, also from the left side, (the latter is of small size).
 One right radius.
 Portion of the superior extremity of an ulna.
 Almost complete set of ankle and toe bones of right front foot.
 Head and neck of left scapula.
 One right acetabulum, (small).
 Body of a right femur.
 Lower extremity of a left femur.
 Two right tibiæ, (one small).
 Two fibulæ, right and left.
 Ten vertebræ, including an axis and atlas.
 Eight ribs.
 One molar of *Equus fraternus*, Leidy.
 One vertebra of *Equus fraternus*, Leidy.

The following are the measurements of the more interesting bones, to-wit :

COMPLETE LOWER JAW :

Length—On outside, from symphysis menti to left angle,
2 ft. 8 ft.

Breadth—Angle to angle, 1 ft. 9 in.

Symphysis menti :

Vertical diameter, $5\frac{3}{4}$ in.

Horizontal diameter, $7\frac{3}{4}$ in.

Girth, 1 ft. 10 in.

Ramus :

* Horizontal diameter, $6\frac{1}{4}$ in.

* Vertical diameter, $6\frac{1}{6}$ in.

* Girth, 1 ft. 9 in.

Aveoli :

One only remains. It is in the right ramus, $1\frac{5}{8}$ in. x $\frac{3}{4}$ in.

Lower Molars :

Right—Length, $5\frac{7}{8}$ in.

" Breadth, $3\frac{3}{4}$ in.

Left—Length, 6 in.

" Breadth, $3\frac{3}{4}$ in.

* Measured immediately in rear of left molar.

Upper Molars:

Right—Length,	6½ in.
“ Breadth,	3⅝ in.
Left—Length,	5¾ in.
“ Breadth,	3⅝ in.

Mandibular Tusks:

* Length—On greatest curvature,	1 ft. 1 in.
“ Tip to root, shortest distance,	10½ in.
* Diameter,	2 in.

LARGE TUSKS:

† Length—‡ On greatest curvature,	9 ft. 1 in.
“ Tip to base, shortest distance,	7 ft. 1 in.
† Diameter at base,	7½ in.
† Diameter of core at base,	3 in.

FREE MANDIBULAR TUSKS:

Length,	9¼ in. and 7¾ in.
Diameter,	1½ in. and 1½ in.

TOOTH IN REMNANT OF JAW:

Length,	6⅝ in.
Breadth,	3½ in.

ENTIRE LEFT HUMERUS:

Length,	3 ft.
Greatest lateral diameter of body,	10 in.
Greatest dorso-ventral diameter of body,	8¼ in.
Lateral diameter of head,	11⅞ in.
Outside of capitellum to outside of trochlea,	9⅛ in.

We have said that there are at least three mastodons represented in this find. Our reasons are easily told.

First.—The occurrence of homologous bones proves the presence of at least two mastodons. For example, we have—

Three tusks and a tip of a fourth.

(One tusk was so far gone as to crumble before preservatives could be applied, and is therefore wanting in the collection.)

One entire left humerus and part of another.

Two right tibiae.

One lower jaw and a portion of another.

Second.—Examination of the mandibular tusks shows that they must have belonged to three animals.

* These figures refer to the right or perfect tusk.

† These measurements made upon the most perfect tusk.

‡ It is estimated that at least 1 ft. 6 in. is wanting at base to complete this tusk.

The complete lower jaw, including its two tusks, represents *one* very old male specimen.

On examining the fragment of a lower jaw, we find that the cavity for the left lower tusk must have been much smaller than the right one. The most perfect of the two loose mandibular tusks fits nicely into the remnant of the right cavity. Although we can not be absolutely certain that either of these tusks belonged to this identical jaw, yet we have shown that not more than one of them could have belonged to it under any circumstances.

Thus we have still left another mandibular tusk to assign to a third proboscidian.

Third.—From the teeth, we find that there are three, and possibly four, mastodons represented.

If we study the free teeth, we shall find (*a*) that two are worn in such a way as to prove them to be the upper teeth of the animal to which the complete lower jaw belonged. (*b*) The two largest and least worn teeth belong to the fragmentary jaw. The size of the teeth, the wear, and, above all, the location when found, satisfactorily prove this statement. (*c*) The two fragments are from the pre-molars of a very young mastodon, as the teats show no signs of wear whatever.* (*d*) There still remain to be accounted for two badly worn teeth, which can either be attributed to another mastodon, or as cast-off teeth of one of the foregoing.

The presence of a very young mastodon is indicated not only by the fragments of teeth already referred to, but by several smaller and badly decomposed bones, viz.:

A portion of a left humerus,
A right tibia, and
A very small acetabulum.

The first two were removed from the excavations only with the utmost difficulty and, afterward, had to be put together with the greatest care, as they contained, upon unwrapping, fifteen and twenty-eight pieces respectively.

For the first time, in south-western Ohio, small bones, other than mastodon, were found with these remains. An inferior molar of an extinct variety of horse (*Equus fraternus* Leidy), which was contemporary with the Mastodon; also, a lumbar

* This opinion has been substantiated by Prof. E. D. Cope.

vertebra of one of the same class of animals, was removed by the writer, who can, therefore, vouch for their genuineness.

But the greatest value of this find consists, not in the number of animals represented, but in the character of some of the parts.

The only complete jaw which was recovered is not only from a very old specimen (the excessive amount of wear to which the last molars have been subjected proves this), but also, it bears *two* well-developed tusks. Prof. E. D. Cope has said,* "In some of the species referred above to Mastodon, mandibular tusks are present in the young, and occasionally one is retained to maturity, as sometimes seen in *M. americanus*. But such individuals are exceptional among their species." Therefore, the most important revelation of this "find" is the presence of two mandibular tusks in an animal which has been satisfactorily proved to be of great age.

The last right superior molar of this specimen presents an interesting peculiarity. It was evidently broken during life, very early in its use, the heel and its corresponding roots being entirely severed from the main body of the tooth. Being loosely retained in the jaw, it could not be utilized for mastication along with the main portion of the tooth. It is evident that, in masticating, the mastodon would bring his teeth together in such a manner as to place the lower heel in rear of the inferior molar and, with every movement of the jaw, wedge it away from its proper place. Thus, it was worn on its anterior surface, while the body of the tooth was worn naturally.

As we have said, hereafter, this find will be noted in scientific circles because of this entire lower jaw with its two mandibular tusks. So far as we know, this is the only jaw of *M. americanus* yet discovered, so well provided with incisors. Combining the fact of the unique peculiarities of this early representative of an ancient race with its striking geological position, we have at once an attractive subject for study, speculation, and research.

So, the Society has in its collection not only an exceptional find from the extinct local fauna, but a specimen that has not

* Prof. E. D. Cope, on "The Proboscidea," in the *American Naturalist*, for April, 1889.

its duplicate in any museum or collection in the world. Even though another be found similarly supplied, the Cincinnati Society of Natural History will have the honor of first finding and describing this unique mastodon jaw.

The writer desires to express his thanks to Prof. E. D. Cope and Dr. Edward Orton for their suggestions and identifications, which were of material assistance in the compilation of this paper.

PHOTOGRAPHY: ITS POSSIBILITIES IN THE
ART-FIELD.

A LECTURE BEFORE THE PHOTOGRAPHIC SECTION, CIN-
CINNATI SOCIETY OF NATURAL HISTORY,
DECEMBER 10, 1894.*

BY LEON VAN LOO.

LADIES AND GENTLEMEN:

I was requested by the members of the Camera Club to deliver an informal talk on "Posing in Portraiture." Deeming this subject too limited in scope to be of general use to the artist, or of much interest to those who are not knights of the camera, but who have honored me with their presence here this evening, I have thought best to select as a theme for this lecture, "Photography, what are its possibilities in the art-field, compared with those of painting?" To answer this question thoroughly, it will be necessary to examine critically, deliberately, the laws that govern and underlie all art. These laws are simply the voices of nature, as expressed in her varied forms, lines, and colors. Repose, rest, indolence, peace, we find suggested by all horizontal lines or masses; the placid waters of pond, lake, or sea; the plains, the prairie, the desert. All living creatures seeking rest, lie down. The dead of all nations, of all times, are laid in their last resting place in horizontal position. The artificial lakes in our cemeteries, upon whose glassy surface are reflected the neighboring tombs, suggest rest, peace. Strength, endurance, dignity, nobility, immortality, are very forcibly expressed by the vertical lines and forms, as seen in the stately pine, the Greek column, the church spire, the shaft that marks the graves of the departed. Action, motion, virility, restlessness, aggression, force, violence, are clearly told in all lines and forms of

* Printed at request of members of the Photographic Section.

acute or right angular shape. When the storm rules supreme, the smooth and shining surface of the waters is changed into angular waves; the giant trees, the saplings, the weeds, the vines, and the grasses, all bend their heads and assume the acute angles of action. Nature in all her phases, passive or active, in whatever mood we may see her, always represents one grand unbroken harmony.

I take this young man as a model, in order to give you an illustration of the very forcible meaning of angles.

This attitude is supposed to represent a beggar. There is a total absence of right or acute angles. In no part of this figure can you find a line that suggests action. The extended arm forms an obtuse angle. The balance of his body is one continuation of curves or passive forms.

(Model now assumes attitude of pugilist.)

Here we have the opposite—strength, aggression, force, action. From head to foot every part of the body has assumed the acute, or right angles. Nature is always in complete harmony; there is no part of this figure passive. In examining the smaller details, let us look at the hands, and we find that each separate joint of the fingers forms a right angle. You may put this closed hand in a sling, and yet it will fight. You can not change its meaning until you change its lines, its angles of action.

Let us see how these facts are observed in all art works.

In Millet's "Angelus" the first thing that strikes us is the mass of horizontal forms and lines; the furrows of the plowed field, the wheel barrow, the clouds, are all made to serve the purpose of suggesting repose, peace. The figures standing, two vertical lines, suggest dignity. Had these peasants been seated, how weak, how indifferent their devotion! Had these people been on their bended knees, how physical, how common-place would have been their prayer!

In contrast to the "Angelus," let us take up a war picture—"Defense of the Gate of Longboyan," by De Neuville. Here, the place selected for the action, not a horizontal plateau, but a sloping hillside. The road that leads up to the gate runs at an angle of forty-five degrees; the artillery going into action, forms an angle a little less acute, and makes a very aggressive angle with the road; the stone wall is

drawn in perspective, so as to produce a line running at an acute angle across the picture; the soldiers fighting are one mass of acute angles. Not a single tree in the middle distance is left in a perfectly perpendicular position, all are more or less leaning, one way or the other, to bring them in harmony with the fight going on in the foreground.

A glance at Gerome's "Golgotha," one of the great works of modern times. Here, great masses of dark clouds, whose forms and lights all run in angular directions, produce a most threatening sky. The shadows of the crosses fall upon the foreground in acute angles, suggesting very forcibly, the cruel deed just done. Had these shadows been made to fall in horizontal lines, suggesting repose, peace, they would have failed to express what Gerome here so thoroughly conveys—Christ still living, still suffering intensely on the cross. So were the malefactors at His side. Again we see these angles express force, aggression, action, violence.

In Munkacsy's "Christ Before Pilate," the figure of the soldier is one of great interest, as it represents in the standing position (the vertical form), dignity, strength, endurance, while the spear, in a horizontal position, suggests repose. This means that no mob violence is to be feared—that one soldier will maintain order, law, respect. Had the artist put the spear at an angle of forty-five degrees, it would have meant that violence was about to be attempted, and the immediate use of the weapon was demanded. Had the painter put the spear in a vertical position, it would have suggested respect only. The soldier presenting arms, when a superior officer passes, holds his weapon, gun or sword, in a vertical position.

These facts, as stated and demonstrated, are not my individual interpretations; nor are they the conventional opinions of any one class, or set of men, artists or critics. They are simply the meanings of nature, expressed through the manifold forms, lines and colors found in the whole universe. From these sources the poet painter draws his inspiration—with this language all true art works must be composed—through this language only can they be understood—by the light of this language alone must they be judged. The general application of this knowledge in the affairs of

our daily life, will do much to better and beautify our surroundings. It will teach us to avoid the senseless overcrowding of our homes with meaningless objects. Especially in America, the parlors of the wealthy are, as a rule, too much filled with costly but inharmonious forms; they seem confused, oppressive; they are lacking in repose, dignity, refinement; they suggest too much the bric-a-brac shop. This knowledge will prevent our architects from putting miniature towers, in the shape of pepper boxes or pilot houses, on every dwelling house they build. Towers are the appropriate parts of castles, surrounded by extensive grounds, or of large structures or public buildings. Had a little of this knowledge been distributed in this city, it would have prevented giving to the splendid statue of President Garfield, by Charles Niehaus, an unsightly tombstone for a base. This same knowledge will guide women in selecting the right colors and proper shapes for all garments that adorn the body, or the many and often fantastic creations that cover their heads. Dress should be in perfect harmony with the size, shape, age, complexion, temperament, intelligence, and station in life of the wearer. It should mark the difference between mistress and maid, matron and miss, and should always very distinctly separate Penelope from Phryne. I trust the time is not far distant when the language of nature will be taught in all our universities, public or private schools, and art academies. I know of no branch of learning that will have so potent an influence for good upon all classes. It teaches the eternal fitness of things. It brings gentleness, good manners, and refinement, while it beautifies and largely enhances the value of all material it shapes or adorns. Jules Claretie tells the story of a farmer and an artist before a small canvas by Rosa Bonheur. The subject, "A Cow." The price asked for the painting, seven thousand dollars. The rustic thought so large a sum for a picture of a single cow was simply preposterous. "Why," said he, "I have bought the finest living cow I ever saw for sixty dollars." "True," replied the artist, "but you forget this great difference; your animal will soon die and be forgotten; this cow is immortal." Art, according to Zola, is "nature seen through the medium of a temperament." This is true and easy of demonstration. About the year 1840, five

great landscape painters, the founders of the French modern school, lived in and about Paris, Barbezon, Fontainebleau, Ville d' Avray. They all painted the same localities; they all lived under the same influences; they often met; some were intimate friends; yet their works in color, composition, treatment, or subject, in no manner or form at all resemble each other. Rousseau painted the intellectual. Daubigny loved the simple, the river Seine and her charming banks. Diaz, the forest. Corot, the poetic, the mysterious. Dupre, the virility of sunlight in color and form. These men of genius saw the same nature, but each selected for illustration from her unlimited sources the subjects most congenial to his mind, and gave them expression through the medium of his temperament. "Painting," said Fromentin, "Is the art of expressing the invisible through the visible." The full meaning of this sentence will be made apparent to all, by calling attention to a few well-known works. Let us look at Munkacsy's "Christ Before Pilate." (The limited time will not permit my taking up more than one figure out of this splendid group.) I will select for my purpose, not the founder of our Christian faith — that exquisite type of Hebrew mold — that noble, intellectual face; nor shall I choose the severe and learned judge. These tell the "invisible" too plainly to claim my attention. I will take the warrior — "The visible," a full-length standing figure in the foreground. In his hand a spear; his back to the beholder; his looks toward the gathered crowd. He who reads the language of art sees in that one soldier, one spear, order, law, authority, the military power of Rome. As a second illustration, let us see what Jean Francois Millet has so beautifully told in his "Angelus." "The visible," a field of labor; in the foreground two peasants, a few implements of toil; in the distance a church spire; over all a glorious sky, in colors of idealistic beauty. "The invisible," Faith, the Christian's religion, hope of a better life to come, the reward for sufferings on earth, immortality. This painting, which, at the Secretan sale in Paris, a few years ago, brought over one hundred thousand dollars, the highest price ever paid for a modern work of similar size, represents a very marked period of evolution in art. This same subject, from the early dawn of painting, has been treated too often

from a very cruel, intensely realistic common standpoint, but always with either the figure of Christ, the Holy family, the Apostles, the high priests, or the set forms of worship, etc. It was reserved for Millet, in October, 1859, leaving all tradition behind, to be the first to convey this theme through the humble, the poor, the untutored of to-day. How simple, how sincere, how profound is the faith here expressed. This condensed review tells us plainly that the "possibilities of photography in the art-field" are quite limited when compared with those of "painting." Before religious or historical subjects, the camera is powerless.

The greatest weakness in photography as an art, lies in the fact that all impressions obtained through lenses are too graphically correct, they give us too much the cold, precise realism of the surface of things; too much infinitesimal, and often meaningless or uninteresting, details. There is a great want of depth, of breadth, of mystery, of the invisible. The inventor who will produce a lens that will reflect upon the sensitized plate, the forms, the lights and shadows of objects placed before it, in broad masses, free from the present minute and often painful definition, will much enlarge the present possibilities of the camera. In *genre* work there are great opportunities for the amateur. The humorous, the sentimental, the varied phases of daily life, are subjects which, with some knowledge of composition, some familiarity with the significance of forms, lines and angles, you can well illustrate. To begin, limit your efforts in this branch to the single figure, or groups of two to four—a greater number will much increase the difficulties of your task, and demands the knowledge of the master to make success possible. To obtain artistic results in landscape photography is quite difficult. It is seldom that we find in nature complete and well-balanced pictures. The very high standard of composition, expression, etc., we have been taught us by the works of illustrious painters. Yet there are great and varied opportunities in outdoor photography. Bryant has well said:

To him who, in the love of Nature, holds
Communion with her visible forms, she speaks
A various language.

You must train the eye to see the picturesque in nature ; the mind to understand the poems found in the fields, in the woods, in the waters, in the mid-day sun, in the gray mist of the early morning, or in the mysterious solitude of somber twilight. With this end in view, study well the works of Lessing for romantic feeling ; for the classic, Schirmer ; the sentimental, in Caspar Scheuren ; for pastoral poems, Cazin ; for sunlight, George Innes ; for dignity, Rousseau ; for the forest, Diaz ; for the mysterious, the poetic, Corot ; for the storm on land or sea, Andreas Achenbach ; for the land of sterility, the massive rocks, the arid, sandy plains, where dwells the savage, the works of our fellow-townsmen, Henry Farny. This brings us to photographic portraiture, where the camera finds its greatest possibilities. Here the operator has full play for showing his knowledge of art, his intelligence, his feeling. Here the subjects before him are pliable at his will. Here the forces of light and shade are at his command. Here, to be successful, you must be a good judge of character ; your perceptive faculties must decide at a glance the dominant traits, the temperament, and general characteristics of your subject, and if in pose you forcibly express these, success is assured. Do not take for models the dramatic attitudes, the twisted draperies, very effective when used by theatrical celebrities, but when applied to men and women in private life, where the license of the stage does not extend, often becomes common, loud, and even vulgar, lacking modesty, refinement, dignity, and repose.

In the studio, make your patron feel at home ; interest him mentally. Do not ask him to look pleasant, to smile ; these expressions may please the weak, but ill become the wise. If the sun pictures made during the past forty years do not fade the future historian will describe us as a very happy, grinning people. When a circus rider appears, talk sawdust ; when the doctor comes, speak of microbe germs ; when the judge, the lawyer, make their appearance, let them do the talking. When a very homely man desires to be immortalized, tell him of the greatness of Socrates or Benjamin Butler, but don't mention the story about Voltaire, who, one day, surrounded by a group of ladies at the court of Louis XV., remarked that men only had the right

to be homely. "Yes, I agree with you," replied Madame Pompadour, "but you abuse the privilege." When a real handsome woman majestically walks under your sky-light, be silent—the mirror has told the required story. When Fall is near, and faded flowers come. The situation is a trying one, as the following facts will tell: A lady, whose sixty Summers and several Springs had whitened her hair, but failed to tarnish the rouge on her fair cheek, or remove the *poudre de riz* from her kindly face, called upon a certain photographer of this city. Arrayed in the brightest of colors, the gayest of dress, with unnumbered ornaments adorned, she appeared before the camera, and said: I have been photographed in Paris, Berlin, London, Constantinople, and Chicago, but never succeeded in getting a picture that looked like me; not one that proved satisfactory to my family or friends; not one that I could recognize; not one that did me justice. Pray tell me, Mr. Tripod, what is the reason for all these failures?" The artist looked solemnly sad, and replied: "Ah, madame, photography is indeed a great art, but it has not yet reached the perfection that enables it to reproduce on paper the real beauties of nature." Yes, there is a humorous side of life in the studio, but there are occasions when the possibilities of the camera bring into play philosophy, science, sentiment, art, knowledge, and even diplomacy.

ANOTHER MIAMI VALLEY SKELETON,*

INCLUDING A DESCRIPTION OF TWO RARE HARPOONS.

BY SETH HAYES,

Museum Director of the Cincinnati Society of Natural History.

On Saturday, September 22, 1894, while gravel was being removed from the bank of Mr. Thos. B. Punshon, in Linwood, Hamilton County, Ohio, two shin bones were noticed protruding from near the top of the sand bank (some sixty feet above the level of the pike).

Unfortunately, the grave was opened at once and its contents removed by inexperienced parties. But, nevertheless, some valuable material was thus secured.

The sand-bank, above referred to, consists of a cut, which is being made into the north-western side of a gravel ridge, which extends in a north-easterly direction on the plateau between Duck Creek and the Little Miami River, in Section 14, of Spencer Township. "On this ridge we have a tumulus and a circular excavation. The tumulus has an elevation of nine feet and a circumference of two hundred feet at the base. It has not been explored, and is covered with young forest trees. Three hundred yards south-west of this tumulus is the circular excavation. Its diameter north to south is forty feet, east to west is forty-four feet, depth seven feet. An old settler related that fifty years ago remains of stakes or palisades could be seen surrounding this excavation."[†]

The grave was about one hundred and thirty-two yards north of the tumulus and some ten yards south-east of the original base of the ridge, and lay about east south-east.

* This skeleton and accompanying relics are in the collection of the Cincinnati Society of Natural History.

[†]Dr. C. L. Metz, on Prehistoric Monuments of the Miami Valley, in the *Journal of the Cincinnati Society of Natural History*, Volume I, p. 119. The tumulus and excavation are shown on his diagram, (Group B, Nos. 1 and 2).

Some eight inches of soil, which originally covered this portion of the ridge, had previously been scraped away, exposing the almost uniform gravel of the bank. When the protruding bones were discovered a sharp outline of the section of the grave was visible, the material filling the grave being a very fine and even sand. No signs of ashes were discovered.

The skeleton was in a horizontal position, while the few relics, which were found with it, were principally on its left side, in the region of the neck and shoulders.



ONE-HALF SIZE.

The relics consisted of a few fragmentary shell and horn beads; bone needles; stone skin dressers, stone war implements; a flat slate pendant; a few hunting and war arrow and spear flint points; beaver teeth; and two finely preserved harpoons.

The harpoons are particularly interesting, as they are the first of the kind that have been recorded as found in the Miami Valley. They have four and five teeth respectively and measure $7\frac{3}{16}$ and $7\frac{9}{16}$ inches in length, and are made from deer horn. All harpoons heretofore found in the numerous graves and mounds opened in the Miami Valley have had only a single tooth, and in most instances were smaller than these specimens.

The skeleton itself was very well preserved. It is of a male, variously estimated to have been from five feet six inches to five feet ten inches in height, and probably about forty years of age. Owing to the manner in which the skeleton was discovered and removed, the toe, ankle, and wrist bones are entirely wanting, while only a few of the finger bones remain.

Otherwise, the skeleton is complete.

In considering the skeleton in detail, we will, as far as practicable, follow the order of treatment of Dr. F. W. Langdon, in his paper upon "The Madisonville Pre-historic Cemetery :

Anthropological Notes."* Inasmuch as this skeleton was found in the vicinity of this famous cemetery, it seemed advisable to so arrange this paper, that it might be the more easily compared with the results of Dr. Langdon's investigations.

The measurements of the skull are tabulated below in comparison with Dr. Langdon's summary, which was based upon the measurements of eighty-three skulls.

MEASUREMENTS.	LINWOOD SKELETON.	LANGDON'S SUMMARY.		
		Maximum.	Minimum.	Mean.
Capacity.....	1470	1660	1110	1337
Length.....	185	187	151	139
Breadth	145	158	122	139
Height.....	142	151	124	135
Index of Breadth.....	.783	.955	.711	.825
Index of Height.....	.767	.894	.689	.799
Width of Frontal.....	102	107	84	93
Zygomatic Diameter.....	146	157	119	136
Height of Orbit—Right.....	34	39	31	35
Left.....	35			
Width of Orbit—Right.....	46	46	37	45.5
Left	47			

From the above table it will be seen that in length, width of frontals, and width of orbit the skull in question corresponds almost exactly with Dr. Langdon's maximum measurements, and agrees only in height of orbit with his mean measurements. The capacity, breadth, height, and zygomatic diameter range about midway between the maximum and mean measurements, while the indices of breadth and height are somewhat below the mean. The index of breadth being between .740 and .800, namely, .783, places this skull among the Orthocephalic types, while those from the Madisonville Cemetery were mostly of the Brachycephalic type.

The temporal process of the malar bone, upon which Dr. Langdon laid particular stress, would be classed by him as well developed. The right process has been broken off, but the left one measures four and one-half mm. in length.

The orbits are no exception to the Madisonville specimens in their marked angularity or extreme proportionate width.

*See Journal of the Cincinnati Society of Natural History, Vol. IV, p. 237.

The left orbit is larger by a millimeter in each diameter than the right, the heights being thirty-five and thirty-four mm., and the widths forty-seven and forty-six mm.

On the lower surface of the nasal tuberosity is a well-marked example of a persistent frontal suture, of about twelve mm. in length.

The "Inca Bone" is not present, nor any forms of wormian bones.

The synostosis of the sutures are marked. The following being present to a greater or less extent, to-wit: sagittal, lamdoidal, coronal, speno-frontal, occipito-mastoid, inter-nasal, and malo-maxillary. Of these, the speno-frontal and malo-maxillary are complete. In each instance the lines of union are almost obliterated. About midway on the line of the malo-maxillary suture, there is a small unusual cavity of spherotriangular outline. It will be considered further on.

The olecranon fossæ are present in both humeri, but that of the right humerus is very minute and almost perfectly circular.

The lateral flattening of the tibiæ (plactycneism) is well marked, while their antero-posterior curvature (cnemecolodosis) is only slight.

The skull bears the marks of two fractures, one being situated at about the middle of the obliterated frontal suture. It is evidently the result of a blow from a blunt instrument. The other is forty-four mm. long and is situated close to the former, but entirely embraced by the right frontal, and, if extended, would make an angle of about thirty-five degrees with the frontal suture. It was evidently made with a sharp-edged instrument. In each case only the outer table was broken, while almost complete repair has taken place.

The only other apparent seat of injury is the abscess cavity of the malo-maxillary suture already mentioned. Its somewhat equilateral triangular form rests with its base on the line of the suture. Its sides measure six mm., base five mm., and depth four mm. In all probability it is the result of a wound from an arrow or spear-point, and has since, by the action of an abscess, assumed its present shape and dimensions.

The lower jaw presents some particularly interesting features. The most prominent of which is the entire absence

of the molars of the left side and the consequent absorption of the bone. In spite of this absorption, the angle of the jaw is very sharp, approaching a right angle. The loss of these teeth, and the resulting absorption, was probably due to an excessive deposit of tartar. The teeth remaining in the jaw bear such a deposit, and in some instances are deeply eaten into. The socket of the first bi-cuspid on the same side, the left, has been the seat of an abscess, and, as a consequence, is greatly disfigured and enlarged, even encroaching upon its neighboring canine. On the right side, the second molar cavity also shows the ravages of this disease, while its accompanying molar is deeply eaten into at the base of the roots. The cavity of the wisdom tooth does not indicate a fully-developed tooth, thus aiding in estimating the age of the specimen. The right canine is remarkable in having two distinct roots.

The eighth rib of the right side was broken nine cm. from its anterior end, but has united by the formation of a false joint.

The femurs, tibiæ, and fibulæ show some interesting pathological features, all of which are more marked upon the bones of the right side. The marks being bi-lateral, indicate some blood disease as their cause.

The disease attacked the right femur about the center of the shaft, after the manner of rarefying osteitis, to an extent of about 16 cm., while marked deposits were made on both of the condyles. The left femur is only slightly injured, and then somewhat lower on the shaft than in case of the right femur.

The right tibia and fibula are the seat of the worst ravages. In the former, about 9 cm. below the tubercle, the enlargement is quite prominent on the crest, but is principally found on the internal surface. Below this, some 8 cm., and situated on the crest, is a small but interesting case of rarefaction. One of the most prominent cases of osteitis appears on the ridge between the posterior and external surfaces. However, about the center of the shaft it spreads to both these surfaces, and finally, near the lower extremity, covers the entire external surface. The popliteal line is almost obliterated by this bony deposit. The entire lower extremity of the bone is diseased.

The left tibia on the other hand is but slightly marked along the crest and lower third of the shaft.

The ridges of the right fibula are all diseased to a greater or less extent. The internal and external borders being overgrown with the irregular deposit of bone, while the lower subcutaneous surface of the shaft is covered by the same material. The left fibula is slightly enlarged at a point corresponding to the disease marks on its accompanying tibia. On the diseased portions of both tibiæ there are marks and depressions that are due either to external accidental causes, or are the imprints of blood vessels. The latter supposition seems more tenable than the former.

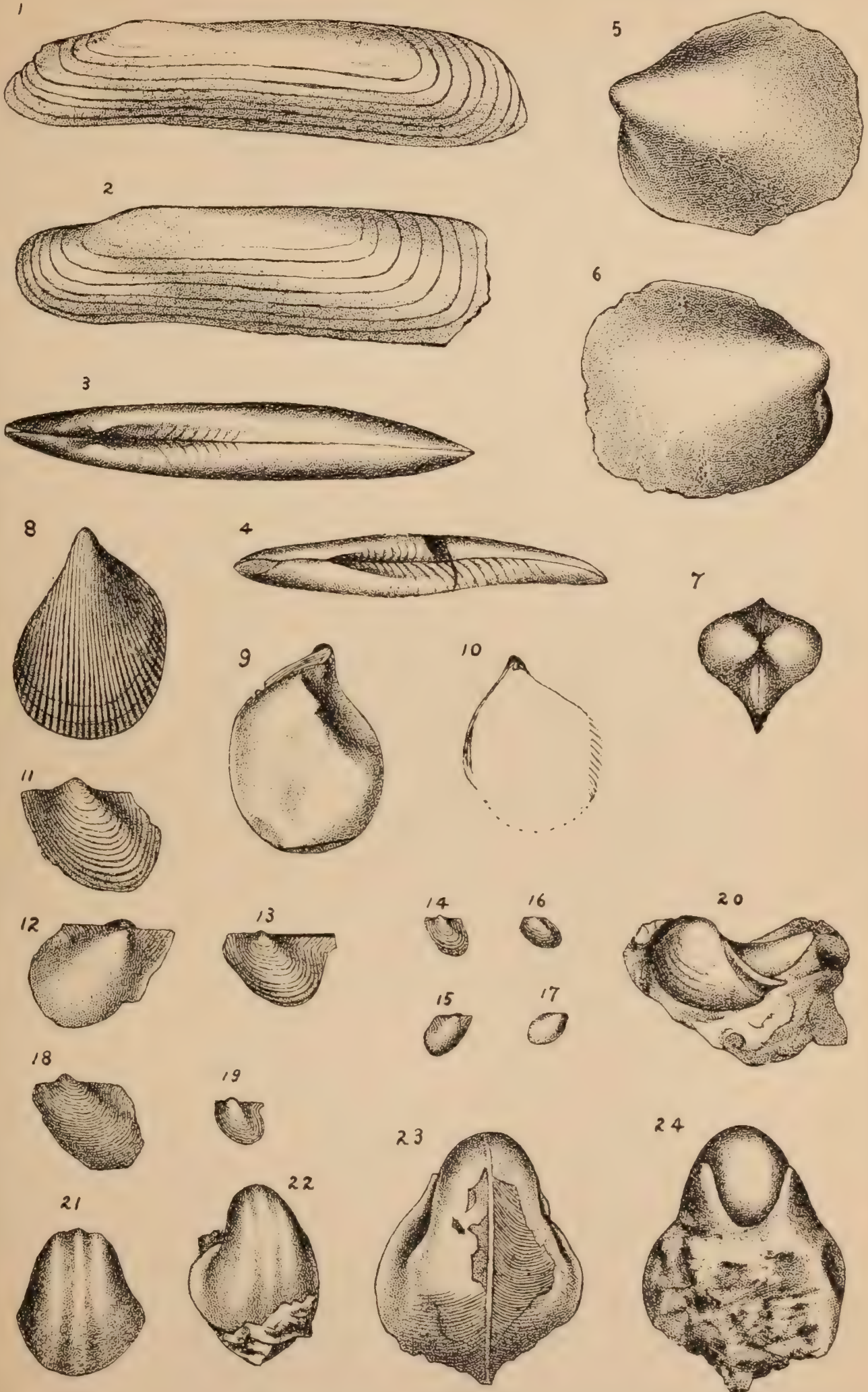
In brief, the skeleton is in a remarkably good state of preservation, and, with the exception of the leg bones, is particularly free from the marks of disease, while the skull differs from all those from the Madisonville cemetery, in having complete synostosis of the malo-maxillary suture. Finally, the two harpoons, which accompanied the skeleton, are truly unique for the Miami Valley.

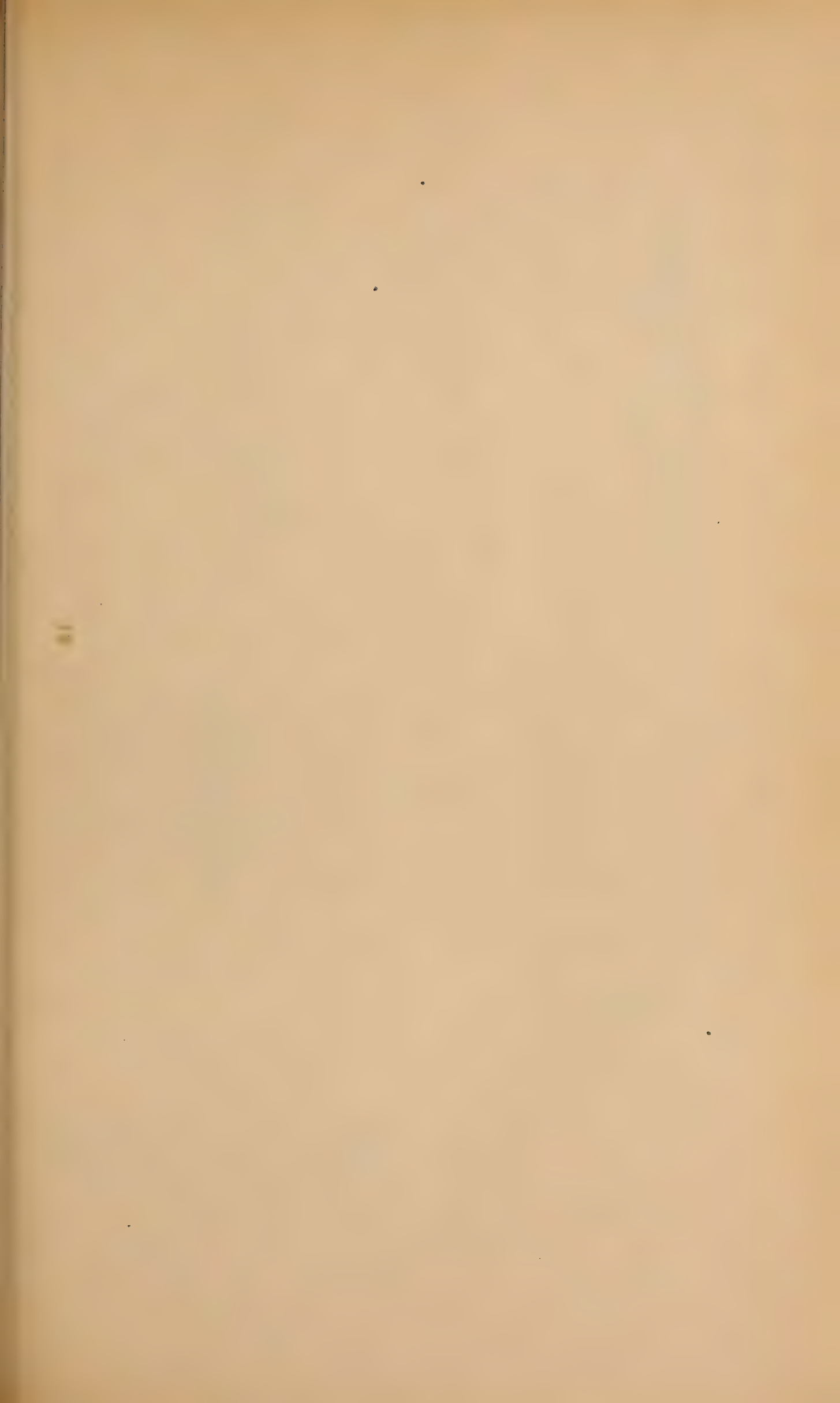
In closing, the writer wishes to express his thanks to Dr. F. W. Langdon and Dr. M. H. Fletcher for their valued suggestions and verifications, which have aided materially in the preparation of this paper.



EXPLANATION OF PLATE I.

	PAGE.
<i>Orthodesma cylindricum</i> , n. sp.,	22
Fig. 1, left side of a good specimen; Fig. 2, left side of another specimen; Fig. 3, dorsal view of the same; Fig. 4, dorsal view of a smaller specimen somewhat injured.	
<i>Bodmania insuetum</i> , n. sp.,	23
Fig. 5, left side view; Fig. 6, right side view of the same specimen; Fig. 7, anterior end view of the same.	
<i>Ambonychia cincinnatiensis</i> , n. sp.,	24
Fig. 8, left valve of an old specimen; Fig. 9, hinge of the same specimen injured at the distal end of the lateral teeth; Fig. 10, hinge and lateral teeth of the left valve of a younger and smaller shell.	
<i>Pterinea cincinnatiensis</i> , n. sp.,	25
Fig. 11, the convex valve of a large specimen; Fig. 12, the opposite valve of the same specimen; Fig. 13, the convex valve of another specimen having the wings better preserved; Fig. 14, the convex valve of a smaller specimen; Fig. 15, the opposite valve of the same; Fig. 16, the convex valve of a very small specimen; Fig. 17, the opposite valve of the same.	
<i>Pterinea rugatula</i> , n. sp.,	26
Fig. 18, view of the left valve of a large specimen, having some of the margin broken away; Fig. 19, view of the left valve of a smaller and more perfect specimen.	
<i>Technophorus faberi</i> , S. A. Miller,	27
Fig. 20, left valve of a large specimen.	
<i>Bellerophon globularis</i> , n. sp.,	28
Fig. 21, dorsal view of a specimen not perfect at the aperture; Fig. 22, dorsal view showing the lateral, backward curve of the aperture.	
<i>Bellerophon cincinnatiensis</i> , n. sp.,	29
Fig. 23, dorsal view of a specimen preserving some of the surface ornamentation of the shell; Fig. 24, ventral view of the same specimen.	





EXPLANATION OF PLATES II AND III.

PLATE II.

Fig. 1.— *Encyrtus buccultrices* Howard. Female.

Fig. 2.— Gall made by *Lasioptera muhlenbergiæ*, on *Muhlenbergia mexicana*.

Fig. 3.— *Hippocephalus multilineatus* Ashmead. Female.

Fig. 4.— *Lygocerus niger* Howard. Female.

Fig. 5.— *Encyrtus flavus* Howard. Female.

Fig. 6.— *Encyrtus flavus* Howard. Male.

PLATE III.

Fig. 1.— *Websterellus tritici* Ashmead. Female.

Fig. 2.— *Websterellus tritici* Ashmead. Male.

Fig. 3.— *Pachyneuron micans* Howard. Female.

Fig. 4.— *Allotria tritici* Fitch.

Fig. 5.— *Perilitus americanus* Riley. Female.

Fig. 6.— Illustrating position of cocoon of *Perilitus* under body of *Megilla maculata*.

ACKNOWLEDGEMENTS.

Fig. 1 of Plate II was secured through the kindness of Dr J. A. Lintner, State Entomologist of New York.

Figs. 2, 5, 6, of Plate II, and Figs. 1, 2, 6, Plate III, are from the Ohio Agricultural Experiment Station.

Fig. 4, of Plate II. and Figs. 3, 4, 5, of Plate III, were received through the kindness of the United States Department of Agriculture.

Fig. 3, of Plate II, from Prof. E. A. Popenoe, of Manhattan, Kansas.



Fig. 1.



Fig. 3.

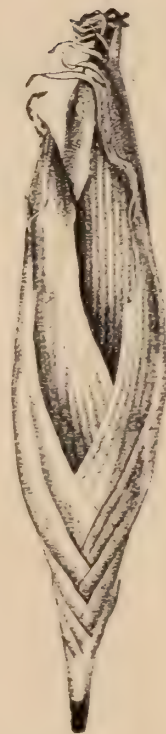


Fig. 2.

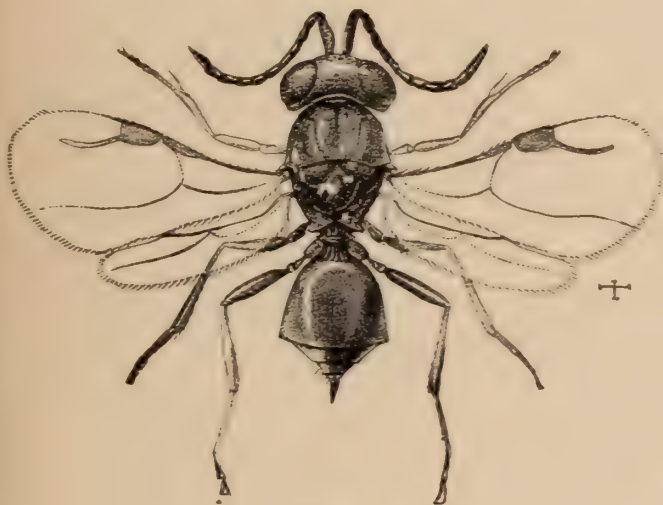


Fig. 4.



Fig. 6.



Fig. 5.



Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.





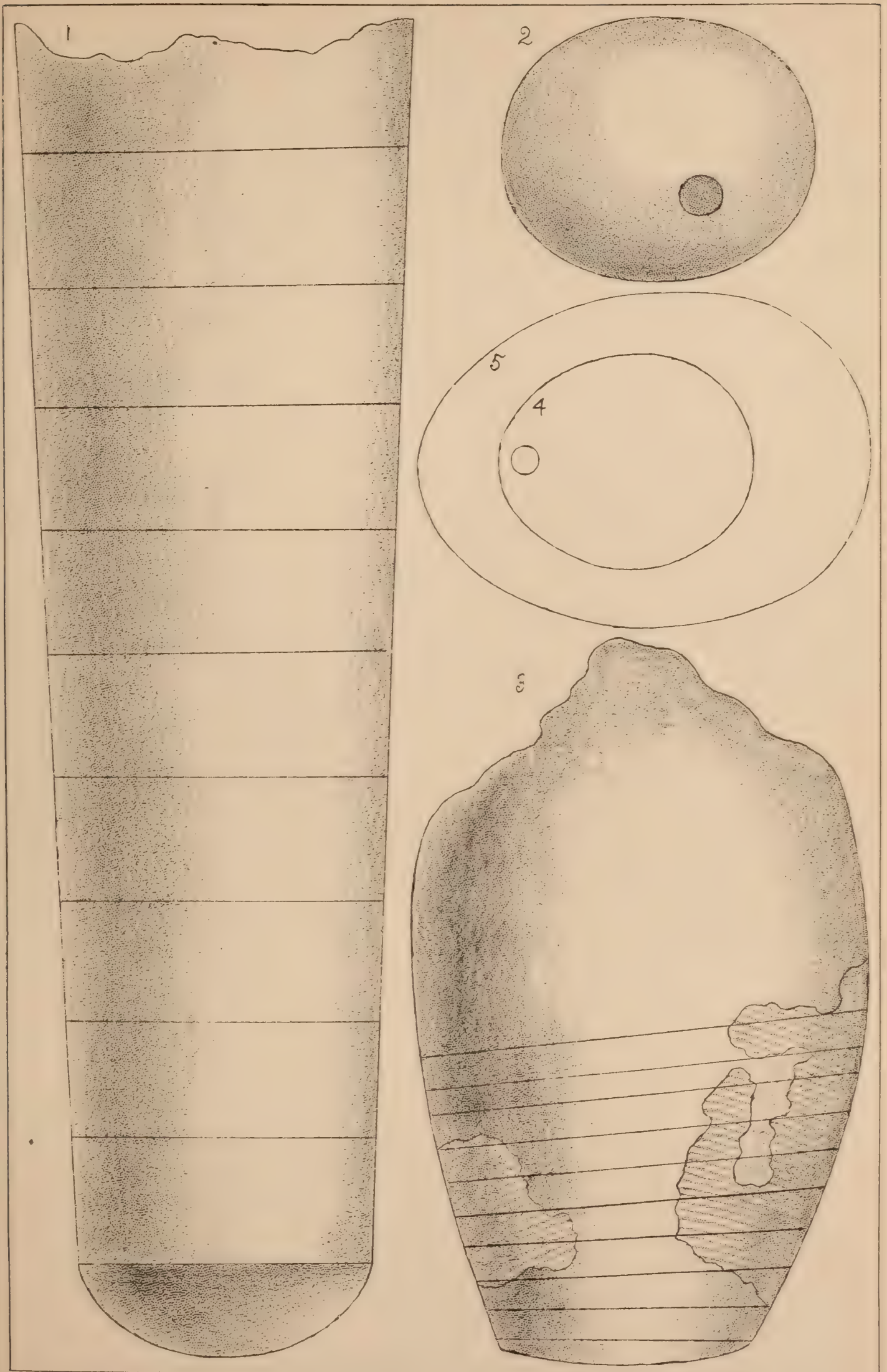
River wall south of Port Deposit, showing creep of strata through gravity.



FIG. 1.—McClenahan & Brother's quarry, showing jointing in the granite-gneiss.

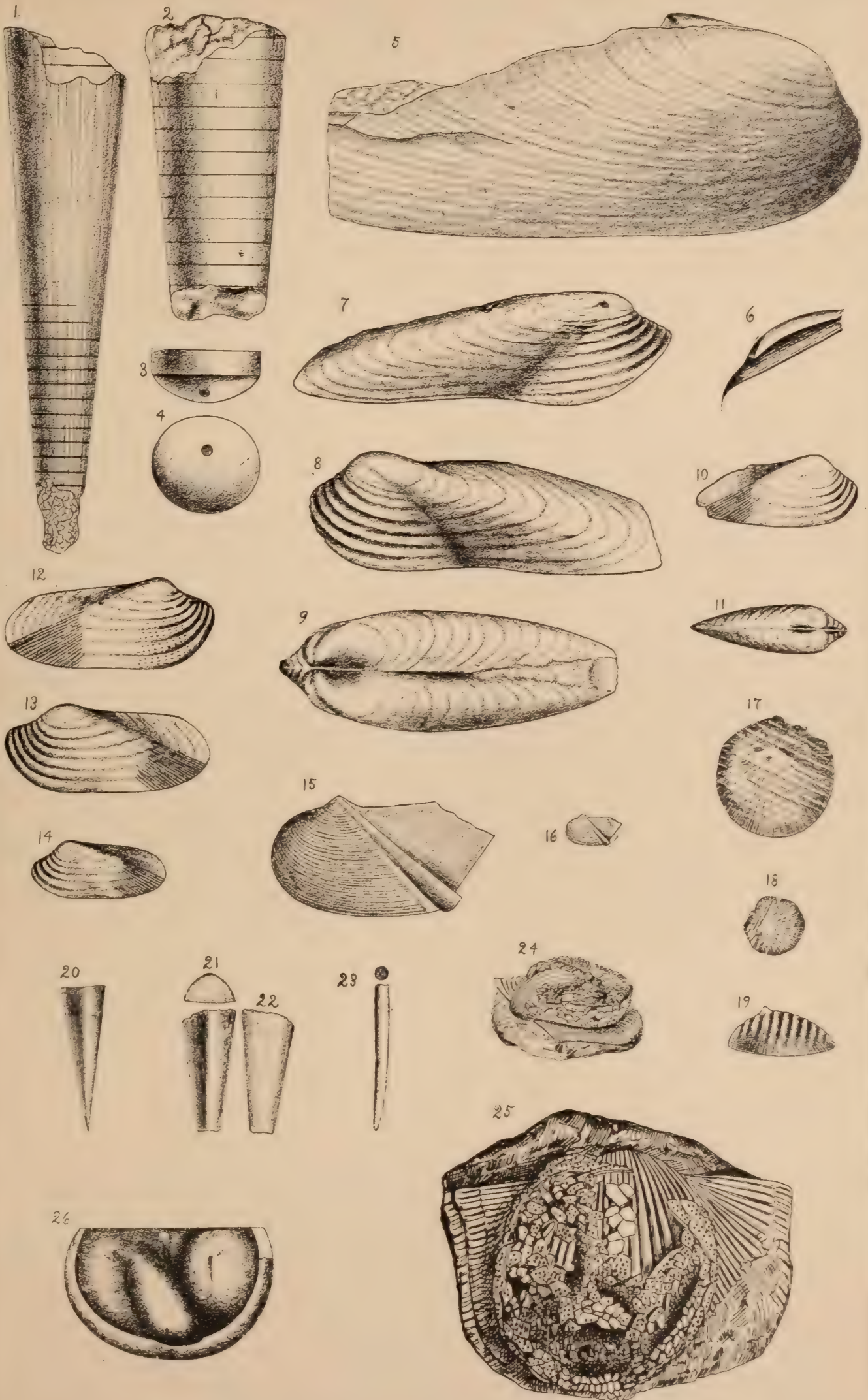


FIG. 2.—Spherical weathering in granite-gneiss, McClenahan & Brother's quarry.



DESCRIPTION OF PLATE VIII.

- Orthoceras albersi* S. A. Miller, 140
 Fig. 1, lateral view, showing part of the shell with its longitudinal furrows; Fig. 2, part of another specimen with the outer shell removed; Fig. 3, a single chamber, showing the convexity of the septa; Fig. 4, an end view, showing the eccentric position of the siphuncle.
- Sphenolium cuneiforme* S. A. Miller, 141
 Fig. 5, part of the right valve of the shell; Fig. 6, the beak and part of the hinge line, showing the ligamental furrow.
- Orthodesma cymbula* n. sp., 143
 Fig. 7, right valve of a nearly complete cast; Fig. 8, left valve of another specimen; Fig. 9, cardinal view of the same, the posterior end is broken, but there is no evidence that the shell was gaping.
- Orthodesma scaphula* n. sp., 145
 Fig. 10, view of the right valve; Fig. 11, cardinal view of the same specimen.
- Orthodesma ashmani* n. sp., 146
 Fig. 12, right valve; Fig. 13, left valve; Fig. 14, left valve of a smaller specimen.
- Technophorus cincinnatiensis* n. sp., 147
 Fig. 15, left valve, magnified four diameters; Fig. 16, same, natural size.
- Crania albersi* n. sp., 154
 Fig. 17, magnified three and a half diameters; Fig. 18, magnified one and three-fourths diameters; Fig. 19, lateral view, magnified three and one-fourth diameters.
- Hyolithes versaillesensis* n. sp., 155
 Fig. 20, magnified four diameters; Fig. 21, transverse section and convex side of a fragment magnified four diameters; Fig. 22, flattened side of same magnified four diameters.
- Hyolithes (?) dubius* n. sp., 155
 Fig. 23, transverse section and side view, magnified in length four diameters and in width three diameters.
- Agelacrinus faberi* S. A. Miller, 156
 Fig. 24, natural size; Fig. 25, magnified two diameters.
- Beyrichia hammelli* n. sp., 157
 Fig. 26, right valve magnified twelve diameters, with a small piece of the border broken away at the antero-dorsal angle.



EXPLANATION OF PLATE IX.

Fig. 1.—*Fidia viticida* Walsh; *A*, adult; *B*, pupa; *C*, larva. Lines indicate natural length. *a*, head of larva from above; *b*, mandible; *c*, antenna; *d*, head of larva from beneath; *e*, maxilla; *f*, labial palpi.

Fig. 2.—*a*, ovipositor of female, showing lateral view of extended terminal joint, with ova in oviduct;* *b*, vertical view of extended ovipositor; *c*, ditto, with terminal section retracted.

Fig. 3.—Appearance of leaf attacked by adult.

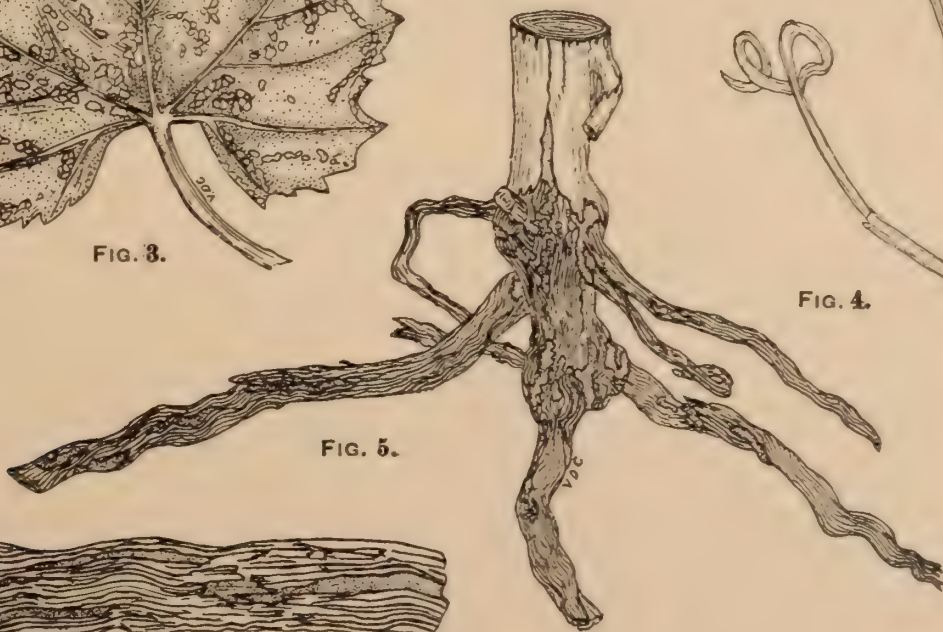
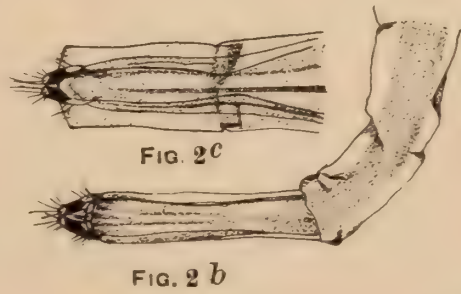
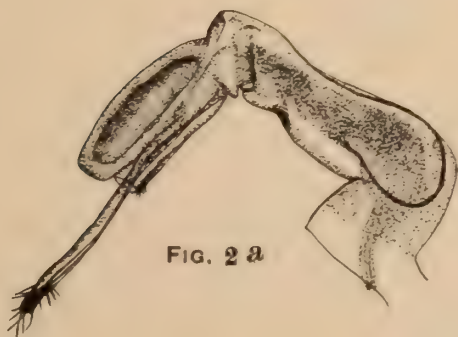
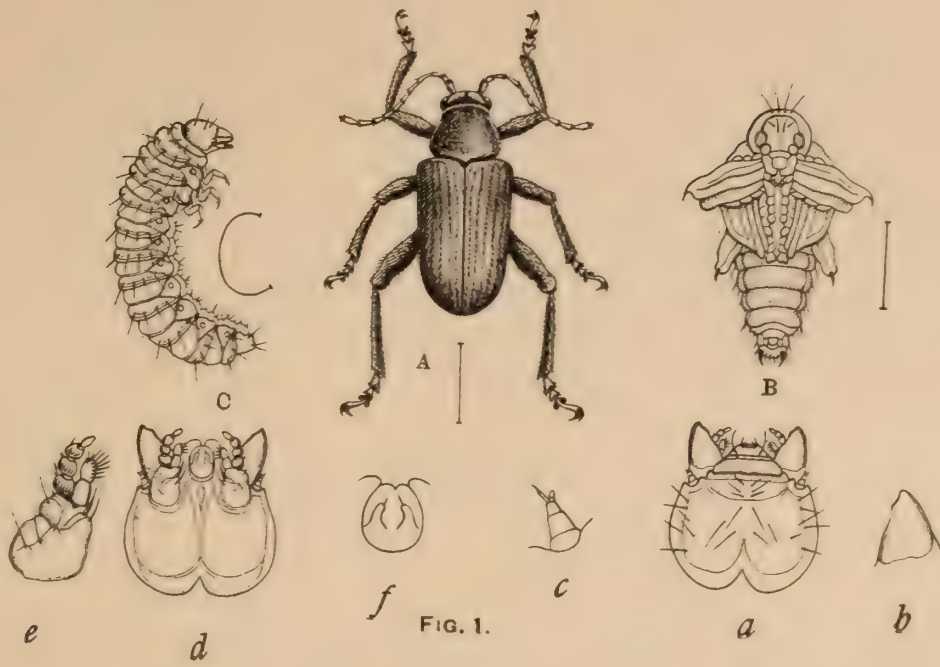
Fig. 4.—Eggs as deposited under bark by female, the bark being partly removed.

Fig. 5.—Appearance of root, attacked by larvæ.

Fig. 6.—Section of small root from Fig. 5.

Fig. 1 was drawn by Mr. Otto Heidemann; Fig. 2, *a*, *b*, *c*, by Miss Freda Detmers; Figs. 3, 4, 5, 6, by Miss V. D. Cunningham.

* Fig. 2 *a*, is drawn from amputated ovipositor of female, taken in the act of ovipositing, and the pressure necessary to prevent her from retracting it may have had something to do with the position of the egg.





CHIMPANZEE (*Troglodytes niger* ♀). THREE VIEWS OF SPECIMEN MOUNTED BY MR. CHAS. DURY.



The Journal of the Cin. Soc. Natural History.

VOL. XVII.

PLATE XII.



JOURNAL

OF THE

Cincinnati Society of Natural History,

VOL. XVIII.

DAVIS L. JAMES, EDITOR.



CINCINNATI:
PUBLISHED BY THE SOCIETY,
1895-1896.

Officers of the Society.

President,	Davis L. JAMES.
First Vice-President,	GEO. W. HARPER.
Second Vice-President,	CHARLES DURY.
Secretary,	T. H. KELLEY.
Treasurer,	T. B. COLLIER.

Members at Large of the Executive Board.

DR. O. D. NORTON,	PROF. C. G. LLOYD,
DR. B. M. RICKETTS,	DR. CHARLES L. EDWARDS.

Directors of Museum and Library.

SETH HAYES, (resigned Aug. 20th, 1895.)
 DR. JOSUA LINDAHL, (since Dec. 4th, 1895.)

Custodian of the Building.

ADDISON McLAUGHLIN.

Regular Meetings—

Of the Society: First Tuesday of each month, 8 P. M.
 Of the Executive Board: First Tuesday of each month, 7 P. M.
 Of the Photographic Section: Second and Fourth Mondays of
 each month, 8 P. M.

TABLE OF CONTENTS.

VOLUME XVIII.

Nos. 1 and 2. *Published Oct. 20th, 1895.*

	Page.
Proceedings.....	1
Report of Director of Museum.....	5
List of Corresponding Societies, etc.....	9
Programme, Fourteenth Course of Free Scientific Lectures.....	23
List of Duplicate Books and Pamphlets in the Library.....	24
Report of Trustees.....	31
Report of Treasurer.....	32
Report of Curator of Photographic Section.....	33
Report of Investments and Securities.....	35
New North American <i>Fungi</i> , by A. P. MORGAN, (Pl. I-III).....	36
Remarks on a "Catalogue of Ohio Plants" by Kellerman and Werner, by JOSEPH F. JAMES.....	46
Mineral Synthesis, by G. PERRY GRIMSLEY, (Pl. IV).....	58
Manual of the Paleontology of the Cincinnati Group, Part VI, by JOSEPH F. JAMES.....	67
Catalogue of Land and Fresh Water Shells found in the vicinity of Cincin- nati, by GEORGE W. HARPER.....	89

Nos. 3 and 4. *Published April 30th, 1896.*

Catalogue of the <i>Odonata</i> of Ohio, Part II, by D. S. KELLICOTT.....	105
Manual of the Paleontology of the Cincinnati Group, Part VII, by JOSEPH F. JAMES.....	115
The Probable Origin and Diffusion of <i>Blissus leucopterus</i> and <i>Murganthia</i> <i>histrionica</i> , by F. M. WEBSTER, (Pl. V).....	141
Illustrations of little known <i>Unionidæ</i> , by R. ELLSWORTH CALL, (Pl. VI)..<	157
An account of the Middle Silurian Rocks of Ohio and Indiana, by AUG. F. FOERSTE, (Pl. VII).....	161
Note on the "Chachalaca," <i>Ortalis vetula maccalli</i> Baird, by CHARLES DURY,	201

Index to New Genera and Species described in Vol. XVIII.

	Page.
A. Fossil Coral, described by JOSEPH F. JAMES.	
<i>Monticulipora verrucosa</i> n. sp.	85
B. Fungi, described by A. P. MORGAN.	
<i>Acrothecium recurvatum</i> n. sp.	44
<i>Argynna</i> Gen. nov.	41
<i>Asterostroma pallidum</i> n. sp.	38
<i>Bolbitius radians</i> n. sp.	36
<i>Calvatia hesperia</i> n. sp.	39
<i>Calvatia leiospora</i> n. sp.	39
<i>Geaster velutinus</i> n. sp.	38
<i>Hemiarcyria montana</i> n. sp.	40
<i>Hydnum atroviride</i> n. sp.	38
<i>Lentodium</i> Gen. nov.	36
<i>Lentodium squamulosum</i> n. sp.	37
<i>Lycogala repleta</i> n. sp.	40
<i>Lycoperdon dryinum</i> n. sp.	39
<i>Marasmius melanopus</i> n. sp.	36
<i>Mitrula roseola</i> n. sp.	42
<i>Monotospora nigra</i> n. sp.	44
<i>Mycogone cinerea</i> n. sp.	45
<i>Peziza nigrans</i> n. sp.	43
<i>Physospora elegans</i> n. sp.	44
<i>Polyporus circumstans</i> n. sp.	37
<i>Pyrenomyxa</i> Gen. nov.	42
<i>Pyrenomyxa invocans</i> n. sp.	42
<i>Reticularia nitens</i> n. sp.	40
<i>Scleroderris rubra</i> n. sp.	43
<i>Streptothrix cinerea</i> n. sp.	44
<i>Trisporium bicornis</i> n. sp.	43

THE JOURNAL

—OF THE—

Cincinnati Society of Natural History.

VOL. XVIII.

CINCINNATI, APRIL-JULY-1895.

NOS. 1 AND 2.

PROCEEDINGS.

March 5, 1895.

The regular March meeting was called to order at 7:36 P. M., with President James in the chair.

The minutes of January 8 were read and approved.

The following propositions for membership were presented and ordered posted for the usual time, to-wit: Prof. Charles L. Edwards, Miss Lucia Stickney, Miss Ellen M. Patrick, Prof. J. U. Lloyd, Dr. Albert A. Springer, Dr. Henry W. Bettman and Mr. Philip W. Ayres.

The name of Mr. Seth Hayes having been duly posted was elected to active membership, the Secretary casting the ballot of the Society for him.

Upon motion, the reading of the minutes of the Executive Board was dispensed with.

The resignation of Mr. F. A. Autenheimer was accepted.

The proposed constitutional amendments were adopted as a whole.

Adjourned at 7:47 P. M.

April 2, 1895.

The Annual Meeting of the Society was called to order at 7:22 P. M., by President James.

The minutes of March 5, read and approved.

The following applications for membership were presented, to wit: Messrs. H. E. Bail, James Murdock and C. Resor.

Upon motion, the Secretary cast the ballot of the Society for the following persons for active membership, to-wit: Prof. Charles L. Edwards, Dr. A. A. Springer, Dr. H. W. Bettman, Mr. Philip W. Ayres, Miss Lucia Stickney, Miss Ellen M. Patrick; and Prof. J. U. Lloyd as a life member.

Upon motion, the reading of the minutes of the Executive Board was dispensed with.

A paper by Prof. Joseph F. James, entitled "Manual of the Palæontology of the Cincinnati Group, Part V," was read by title, and referred to the Publishing Committee.

The resignations of Messrs. G. G. Johnson and C. L. Harrison were accepted.

Mr. T. B. Collier, the Treasurer, presented his annual report, which is made a part of these minutes.

The Trustees, through Mr. A. A. Ferris, presented their report, which is attached hereto.

Acting upon the suggestion of the Trustees, the President and Treasurer were appointed a committee to inspect the loans made by said Trustees.

The chair appointed Messrs. Chas. Dury, T. H. Kelley and J. U. Lloyd, as a committee to audit the Treasurer's accounts.

Nominations being called for, Mr. Davis L. James was nominated to succeed himself as President.

The nominations were declared closed after a vote.

Upon motion, it was decided to vote for all officers at one time, except where more than one nomination be made for any office.

Prof. George W. Harper was nominated as First Vice-President. Whereupon the nominations were closed.

Mr. Charles Dury was nominated for Second Vice-President and nominations closed.

Dr. P. M. Bigney was nominated to succeed himself as Trustee. Upon motion, the nominations were closed.

Mr. T. H. Kelley was renominated as Secretary. Nominations closed.

Mr. T. B. Collier was again nominated for Treasurer.

The following gentlemen were nominated for members of the Executive Board at-large, to-wit: Dr. O. D. Norton, Prof. C. L. Edwards, Dr. B. M. Ricketts and Prof. C. G. Lloyd.

Nominations were closed by motion.

Mr. Seth Hayes was nominated as Librarian. Nominations closed.

The following Curators were nominated, to-wit:

Geology—Prof. George W. Harper.

Botany—Prof. C. G. Lloyd.

Zoology—Charles Dury.

Anthropology—Warren K. Moorehead.

Photography—None.

Microscopy—Dr. A. A. Springer.

Physics—Prof. Thomas French, Jr.

Chemistry—Prof. J. U. Lloyd.

Upon motion, the Secretary cast the ballot of the Society for the several nominees and they were declared duly elected to their respective offices.

After adjournment at 7:45 P. M., the Society listened to a most instructive and interesting lecture, by Prof. E. W. Claypole, of Akron, Ohio.

May 7, 1895.

The Society was called to order at 8:32 P. M., President James in the chair.

The minutes of April 2, were read and approved.

The application of Dr. Charles A. L. Reed was read and ordered posted.

The names of Messrs. H. E. Bail, Joseph Murdock and C. Resor were balloted for and duly elected.

The reading of the minutes of the Executive Board was dispensed with.

Upon recommendation of the Photographic Section, Mr. Edward E. Shipley was elected Curator of Photography.

The committee appointed to inspect the securities held by the Trustees reported through Mr. James that the securities, amounting to \$41,100.00, were in good condition.

Upon motion, the report was received and ordered spread upon the minutes.

Adjourned at 8:40 P. M.

June 4, 1895.

The regular June meeting of the Society was called to order with Second Vice-President Dury in the chair.

Dr. Charles A. L. Reed was elected to active membership.

The reading of the minutes of the Executive Board was dispensed with.

Nominations to fill the vacancy among the Trustees caused by the death of Dr. P. M. Bigney being declared in order, Mr T. B. Collier nominated Mr. T. H. Kelley to serve the unexpired term.

Mr. A. A. Ferris requested the postponement of election of Trustees until more members were present.

Upon motion, the nominations were declared closed and the Acting Secretary was instructed to cast the ballot of the Society for Mr. Kelley.

The ballot being so cast Mr. Kelley was declared duly elected.

The resignations of Messrs. Charles Barnes and E. H. Barton were accepted.

Adjourned at 8:20 P. M.

REPORT OF DIRECTOR OF MUSEUM.

CINCINNATI, O., April 2, 1895.

TO THE OFFICERS AND MEMBERS OF THE CINCINNATI SOCIETY OF
NATURAL HISTORY.

Ladies and Gentlemen:—In accordance with the Constitution and custom of the Society, I hereby present to you my third annual report as Director of the Museum.

The Museum is in better condition to-day than it has ever been. Considering our cramped quarters and the fact that one-half of our building is a remodeled dwelling, the impression given by a general survey of the various rooms and collections is quite satisfactory. In this connection I cannot speak too highly of the manner in which Mr. Addison McLaughlin, Custodian of the Building, has looked after the interests of the Society, not only in caring for the building, and making such repairs and changes in building and fixtures as increasing and rearranged collections required, but by valuable assistance rendered in the acquisition, preservation and care of donations and additions to the museum material.

GEOLOGY.

During the past year very valuable additions have been made to the Department of Geology. The most important, not only in quantity of material, but because of its local and general value, is the donation of the Mammalian remains found in Hyde Park last June, by Miss Louise Shaw.

It is unfortunate that our collections in this department, although large and valuable, as a whole only represent Palæontology and Crystallography. Inasmuch as this department is to be the principal one rearranged and overhauled this summer, an effort will be made to obtain a series of rocks, representing the geological column of Ohio, while a typical series of the fossils of the Hamilton group at Cincinnati (long designated as the Cincinnati group), indicating their horizons and including strata.

BOTANY.

The Botanical collection of the Society has unfortunately received no additions during the past twelve months, hence it remains as when last reported; in good condition, of easy access to botanical students but in need of many species to round it up.

There has been some agitation concerning the organization of a Botanical Section. Such a section would not only unite our botanists to their mutual advantage, but it would be of inestimable value to the Society and especially to this department. It is to be hoped that the Curator of Botany will take advantage of this announced desire and at once take steps to organize the section.

ZOOLOGY.

The department of Zoology is without doubt the most active and consequently its collections are growing more regularly than any of the unorganized departments.

At present, the collections are arranged as they were a year ago. However, their cases are overcrowded and are infringing on the Palæontological cases to such an extent as to make the recommendation of last year, concerning a new wall case, almost imperative.

ANTHROPOLOGY.

The Anthropological work of the Society, heretofore one of its most valuable lines of research, has of late been somewhat secondary. The past year has brought to the Society one valuable addition to their already large collection. A skeleton and accompanying remains from Linwood, donated by Mr. Thos. B. Punshon.

MICROSCOPY, PHYSICS AND CHEMISTRY.

The departments of Microscopy, Physics and Chemistry have for three years past been departments in name only. Of the three there is no reason why Microscopy should not occupy the prominent place which of right belongs to it in scientific investigations and societies. The other departments are not usually included in American Natural History Societies, which may account for their present condition. But since including them, we have patterned after foreign organizations,

we should also follow their example still further and revive interest therein, or else abandon them as departments.

PHOTOGRAPHY.

The work and condition of the Photographic Section is fully equal to that of a year ago, although they have lost quite a number of members. The Curator of this department, Mr. H. J. Buntin, will present you a detailed report.

LIBRARY.

The classification and cataloguing of the books and pamphlets in the library is progressing slowly but steadily as time will permit. Just at present the pamphlets are in hand. They will soon be arranged and filed in such a manner as to be of easy access and protected from the ravages of dust, until bound.

The exchange list has been materially increased by the addition of forty-five corresponding societies and institutions, while a very few have been stricken from the list for various reasons.

A revised list of the correspondents and a partial list of duplicate volumes and periodicals is hereto attached and made a part of this report.

It is proposed to continue the work along these lines until the library is not only available, but in first-class condition.

LYCEUM.

This year the Lyceum has taken a much more satisfactory form. Instead of being simply a class under the direction of your Director, it is now a regularly organized body with a full quota of officers, all of whom are elected by the Lyceum, except their President, who is appointed by your Executive Board.

The Constitution is so drawn as to place the Lyceum under the control of this Society and by its terms will tend to increase the membership of the Society proper.

The Lyceum is intended mainly for young people, but provision is made for older members who are members of the Society.

It is the intention of the Lyceum to organize and maintain such classes in Natural History as may be in demand, in each instance making the work as practical as possible.

STUDENTS COLLECTIONS.

Provision should be made for these students, in the way of small but typical sets, not only of hard, but soft, alcoholic specimens suitable for dissection and sectioning. Local material is easily obtained, hence particular attention should be given to salt-water species.

Moreover the preparation and publication of check lists and artificial keys to certain of the local fauna and flora would not only assist these young collectors, but be of great value to the teachers of natural science working in this vicinity.

LECTURE COURSE.

The Lecture Course this year is the result of the work of the Executive Board acting as a whole. For some unaccountable reason the committee which was elected for the purpose was unable to formulate a report in time for the season, hence the action of the Board.

However, it has been shown by the large audiences present at the first two lectures, that a shorter course better fulfills the aim of the Society in offering them to the public. These short courses can be made much more choice, at the same expense, than longer ones. Consequently, if this accidental model is followed in the future the committees will have a better opportunity of presenting to Cincinnati audiences some of America's greater scientific lights.

A programme of this year's course of free scientific lectures is attached to and made a part of this report.

The Society is to be congratulated upon the signs of increasing interest in its work, as evidenced by the recent increase in membership, the organization of the Lyceum and agitation concerning the organization of a Botanical Section.

If the closing three months of this year are any criterion, we may well feel confident that the coming twelve months will be the banner year of our history.

Respectfully submitted,

SETH HAYES,

Director of the Museum.

LIST OF CORRESPONDING SOCIETIES, ETC.

UNITED STATES.

ALABAMA.

Auburn.

Alabama Agricultural and Mechanical College.
University.

Geological Survey of Alabama.

ARKANSAS.

Arkansas Geological Survey (see Stanford University, Cal.)
Fayetteville.

Arkansas Industrial University.

CALIFORNIA.

Berkeley.

University of California.
Agricultural Experiment Station.
Department of Geology.
Library.
University of California studies.

San Francisco.

California Academy of Sciences.
California State Mining Bureau.
Technical Society of the Pacific Coast.
Stanford University.
Prof. J. C Branner, for Ark. Geol. Survey.

COLORADO.

Colorado Springs.
Colorado College Scientific Society.
Denver.
Colorado Scientific Society.
Ft. Collins.
State Agricultural College.

CONNECTICUT.

Meriden.

Meriden Scientific Association.

New Haven.

American Journal of Science.

Connecticut Academy of Arts and Sciences.

Connecticut Agricultural Experiment Station.

DELAWARE.

Newark.

Delaware College.

DISTRICT OF COLUMBIA.

Washington.

American Microscopical Society.

Anthropological Society.

Biological Society.

Department of Agriculture.

Bureau of Animal Industry.

Division of Botany.

Division of Chemistry.

Division of Economic Ornithology and Mammalogy.

Division of Entomology (Insect Life).

Division of Forestry.

Division of Microscopy.

Division of Pomology.

Farmer's Bulletins.

Library.

Office of Experiment Stations.

Office of Road Inquiry.

Secretary.

Statistician.

Section of Vegetable Pathology (Journal of Mycology).

Weather Bureau.

Department of the Interior.

Bureau of Education.

United States Geological Survey.

Entomological Society.

Philosophical Society.

DISTRICT OF COLUMBIA.—Continued.

Smithsonian Institution.

Library.

United States National Museum.

Bureau of Ethnology.

United States Fish Commission.

United States Naval Observatory.

United States Patent Office.

War Department.

Surgeon General's Office.

GEORGIA.

Experiment.

State College of Agricultural and Mechanical Arts.

ILLINOIS.

Champaign.

State Laboratory of Natural History.

University of Illinois.

Chicago.

Field Columbian Museum.

University of Chicago Press (Journal of Geology).

Good Hope.

American Antiquarian.

Springfield.

Illinois State Museum of Nat. Hist. (Illinois Geol. Survey).

INDIANA.

Bloomington.

Botanical Gazette.

Brookville.

Indiana Academy of Sciences.

Indianapolis.

State Geological Survey.

IOWA.

Ames.

Iowa Agricultural College.

Davenport.

Davenport Academy of Sciences.

IOWA.—Continued.

Des Moines.

Iowa Academy of Sciences.

Iowa Geological Survey.

Iowa City.

University of Iowa.

KANSAS.

Lawrence.

Kansas University Quarterly.

Manhattan.

Kansas State Agricultural College.

Topeka.

Kansas Historical Society.

Washburn College Laboratory.

KENTUCKY.

Frankfort.

Kentucky Geological Survey.

Lexington.

Kentucky Agricultural Experiment Station.

LOUISIANA.

New Orleans.

Louisiana Experiment Station.

MARYLAND.

Baltimore.

Johns Hopkins University.

Maryland Academy of Sciences.

College Park.

Maryland Agricultural College.

MASSACHUSETTS.

Amherst.

Massachusetts Agricultural College.

Boston.

American Academy of Arts and Sciences.

Boston Society of Natural History.

Massachusetts State Board of Agriculture.

MASSACHUSETTS.—Continued.

Cambridge.

Museum of Comparative Zoology.

Peabody Museum of Archæology and Ethnology.

Psyche.

Salem.

American Association for the Advancement of Science.

Essex Institute.

Tufts College.

Tufts College Library.

Wood's Holl.

Marine Biological Laboratory.

MICHIGAN.

Agricultural College.

Michigan State Agricultural College.

MINNESOTA.

Minneapolis.

American Geologist.

Minnesota Academy of Natural Sciences.

Minnesota Geological and Natural History Survey.

St. Anthony Park.

University of Minnesota.

MISSISSIPPI.

Agricultural College.

Mississippi Agricultural and Mechanical College.

MISSOURI.

Jefferson City.

Geological Survey of Missouri.

St. Louis.

Academy of Natural Sciences.

Missouri Botanical Garden.

NEBRASKA.

Lincoln.

University of Nebraska.

Experiment Station.

University Studies.

NEW JERSEY.

New Brunswick.

Geological Survey of New Jersey.

New Jersey State Microscopical Society.

Rutgers College.

NEW YORK.

Albany.

Albany Institute.

Hall, Prof. James.

New York State Library.

New York Museum.

Buffalo.

Buffalo Historical Society.

Buffalo Society of Natural History.

Flatbush.

New York Microscopical Society.

Geneva.

New York Experiment Station.

Ithaca.

Cornell University.

New Brighton.

Staten Island Natural Science Association.

New York City.

American Geographical Society.

American Museum of Natural History.

Auk, The.

Columbian College.

School of Mines Quarterly.

Torrey Botanical Club.

Linnean Society of New York City.

New York Academy of Sciences.

New York Microscopical Society.

Popular Science News.

Poughkeepsie.

Vassar Brothers' Institute.

Rochester.

Rochester Academy of Science.

NORTH CAROLINA.

Chapel Hill.

Elisha Mitchell Scientific Society.

Raleigh.

North Carolina Agricultural Experiment Station.

OHIO.

Cincinnati.

Public Library.

University of Cincinnati (Cincinnati Observatory).

Young Men's Christian Association.

Columbus.

Archæologist, The.

Columbus Horticultural Society.

Ohio State Academy of Science.

Ohio State Board of Agriculture.

Ohio State University (Ohio Geological Survey).

Granville.

Denison Scientific Association (Denison University).

Journal of Comparative Neurology.

Oberlin.

Oberlin College Library.

Wooster.

Ohio Agricultural Experiment Station.

OREGON.

Corvallis.

Oregon State Agricultural College.

PENNSYLVANIA.

Philadelphia.

Academy of Natural Sciences.

Entomological News.

Nautilus, The.

American Naturalist.

American Philosophical Society.

Journal of Comparative Medicine and Veterinary Archives.

Pennsylvania Geological Survey.

Wagner Free Institute of Science.

State College.

Pennsylvania State College.

RHODE ISLAND.

Newport.

Newport Natural History Society.

TEXAS.

Austin.

Geological Survey of Texas (Dept. Agr. Ins. Stats. and Hist.)
College Station.

Agricultural and Mechanical College of Texas.

UTAH.

Logan.

Utah Agricultural College.

VIRGINIA.

Blacksburg.

Virginia Agricultural and Mechanical College.

WEST VIRGINIA.

Charleston.

West Virginia Agricultural Experiment Station.

WISCONSIN.

Madison.

State Historical Society.

Wisconsin Academy of Science, Arts and Letters.

Milwaukee.

Natural History Society of Wisconsin.

Public Museum.

WASHINGTON.

Pullman.

Washington Agricultural College and School of Science.

WYOMING.

Laramie.

University of Wyoming.

FOREIGN COUNTRIES.

AFRICA.

Cape Town.

Department of Agriculture.

South African Philosophical Society.

ARGENTINE REPUBLIC.

Buenos Ayres.

Argentina Historia Natural.

Cordova.

Academia Nacional de Ciencias.

AUSTRALIA.

Adelaide.

Royal Society of South Australia.

Melbourne.

Victoria Public Library, Museum, and National Gallery.

Sydney.

Department of Agriculture.

Linnean Society.

Hon. Minister of Mines, Department of Mines.

Royal Society.

AUSTRIA.

Vienna.

Kaiser König Geologischen Riechanstalt.

K. K. Naturhistorischen Hofmuseum.

BELGIUM.

Brussels.

Societe Royale Malacologique.

BRAZIL.

Rio de Janeiro.

Museo Nacional.

CANADA.

Halifax.

Nova Scotia Institute of Natural Sciences.

London.

Canadian Entomologist.

Entomological Society of Ontario.

Montreal.

Canadian Record of Science.

Ottawa.

Canadian Geological and Natural History Survey.

Ottawa Field Naturalists' Club (Ottawa Naturalist).

St. John.

Natural History Society.

Toronto.

Canadian Institute.

Winnipeg.

Manitoba Historical and Scientific Society.

CHILE.

Santiago.

Deutschen Wissenschaftlichen Vereins in Santiago.

Societe Scientifique du Chili.

COSTA RICA.

San Jose.

Museo Nacional.

ENGLAND.

Bristol.

Bristol Naturalists' Society.

London.

Entomologist Record and Journal of Variation.

Geological Society of London.

Royal Microscopical Society.

Manchester.

Manchester Literary and Philosophical Society.

Penzance.

Royal Geological Society of Cornwall.

FRANCE.

Marseilles.

Faculte des Sciences d' Marseilles.

Nantes.

Societe des Sciences Naturelles, etc.

Neuchatel.

Societe des Sciences Naturelles des Neuchatel.

Paris.

Societe Entomologique de France.

Societe Zoölogique de France.

Toulouse.

Academie des Sciences, Inscriptions et Belleslettres.

GERMANY.

Augsburg.

Augsburg Naturhistorischen Verein.

Berlin.

Botanischen Verein der Provinz Brandenburg.

Braunschweig.

Braunschweig Verein für Naturwissenschaft.

Bremen.

Bremen Naturwissenschaftlichen Verein.

Cassel.

Cassel Verein für Naturkunde.

Frankfort-on-Order.

Natur Verein des Reg Bez.

Giessen.

Oberhessische Gesselschaft für Natua und Heilkunde.

Halle.

Kaiser Leop-Carol Deutschen Akademie dur Naturforschen.

Kassel.

Vereins für Naturkunde zu Kassel.

Leipsig.

Verein für Erdkunde.

Munster.

Westfalichen Provinzial Verein für Wissenschaft und Kunst.

Stuttgart.

Verein für Vaterländische Naturkunde in Wurttemberg.

HOLLAND.

Leiden.

Netherland Zoölogical Society.

HUNGARY.

Budapest.

Ethnologische Mittheilungen aus Ungarn.

Trencsin.

Natural History Society of Trencsin.

INDIA.

Calcutta.

India Geological Survey.

India Survey Department.

India Museum.

ITALY.

Naples.

Societe Africana d' Italia.

Pisa.

Societa Toscana di Scienza Naturali.

Rome.

Ministero di Agricoltura, Industria e Commercio.

Turin.

Torino Musei di Zoölogica ed Anatomia Comparata.

IRELAND.

Dublin.

The Irish Naturalist.

JAPAN.

Tokio.

Deutschen Gesellschaft fur Natur und Volkerkunde Ostaiiens.

Japan Imperial University.

MEXICO.

City of Mexico.

Deutschen Wissenschaftlichen Vereins in Mexico.

Museo Nacional de Mexico.

Sociedad Mexicana de Historia Natural.

Sociedad Cientifica, "Antonio Alzate."

Puebla.

Sociedad de Ingenieros de Puebla.

NORWAY.

Christiana.

Royal University of Norway.

PHILIPPINE ISLANDS.

Manila.

Compania de Jesus.

RUSSIA.

Kiew.

Kiew Societe des Naturalistes.

Moscow.

Societe Imperiale des Naturalistes de Moscou.

St. Petersburg.

Comite Geologique de Russie.

SCOTLAND.

Edinburgh.

Botanical Society.

Edinburgh Geological Society.

Royal Society.

Royal Physical Society.

Royal College of Physicians.

Glasgow.

Natural History Society.

SPAIN.

Barcelona.

Barcelona Academia di Ciencias y Artes.

SWEDEN.

Stockholm.

Institute Royale Geologique de la Suede.

Kongl. Vetenskaps Akadamiens Forhandlingar.

Societe Entomologique a Stockholm.

SWITZERLAND.

Basel.

Basel Naturforschenden Gesellschaft.

Bern.

Bern Naturforschenden Gesellschaft.

Geneve.

La Societe Botanique Suisse.

Lausanne.

Societe Vaudoise des Sciences Naturelles.

Zurich.

Naturforschenden Gesellschaft.

Schweizenschen Botanischen Gesellschaft.

TRINIDAD.

Port of Spain.

Victoria Institute of Trinidad.

PROGRAMME.

FOURTEENTH COURSE OF FREE SCIENTIFIC LECTURES, 1895.

TUESDAY, MARCH 5.

"A VOYAGE OF DISCOVERY."

CHARLES L. EDWARDS,

Professor of Biology, University of Cincinnati.

TUESDAY, MARCH 19.

"CRYSTALS."

N. W. LORD,

Professor of Mining and Metallurgy, Ohio State University.

TUESDAY APRIL 2.

"THE MAKING OF OHIO."

E. W. CLAYPOLE,

Professor of Geology, Buchtel College.

TUESDAY, APRIL 16.

"CERAMICS."

EDWARD ORTON, JR.,

Professor of Ceramics, Ohio State University.

LIST OF DUPLICATE BOOKS OR PAMPHLETS IN THE
LIBRARY OF THE CINCINNATI SOCIETY
OF NATURAL HISTORY.

BOUND VOLUMES.

- American Pharmaceutical Association.—Proceedings 1868, 1871.
Arkansas Geological Survey.—Annual Report, 1888, Vol. I.
Harpers Weekly,—Vol. V, 1861; VI, '62; VII, '63; VIII, '64; IX, '65.—(Years of the Civil War.)
Henshaw, H. W.—Report on Ornithological Collections.—Extract from U. S. Survey, west of 100th meridian.
Illinois Geological Survey.—Vol. VII.
Indiana Geological Survey, 1872.
Indiana Geological and Natural History Survey, 1888.
Kentucky Geological Survey.—Vol. IV.
Massachusetts, Geology of.—Hitchcock, 1841.
Minnesota, Geological and Natural History Survey of.—Vol. I.
Minnesota Survey of.—Geological Reports, 1880, '82.
Missouri Botanical Gardens.—Reports 1891, '92, '93, '94.
New York, Natural History of.—Parts I; III; IV; VI, Vol. I; VI, Vol. II.
Ohio Agricultural Reports, 1860, '65, '68, '72, '72 in german, '73, '73 in german, '74, '74 in german, '76, '77, '78, '82, '83, '93.
Ohio Centennial Report.
Ohio Geological Survey.—Mather's 1838, Report 1870, Maps 1873.
Volume I in german, II, II in german, III, IV, V, VI with maps, VII with maps.
Palæontology I, II, II in german.
Ohio Meterological Bureau, 1884, '83.
Ohio Statistics, 1871, '72, '74, '75 in german, '77, '78 '81; '82, '83, '84.

Pennsylvania, Second Geological Survey of.—1874, “B,” “C,” “D,”
“H,” “K,” “M,” and 1875 “CC,” “HH,” Maps “CCC.”

Smithsonian Institution.

Reports 1856, '58, '72, '78, '79, '81, '86 Pt. I, '86 Pt. II, '87,
'88, '89.

Contributions to Knowledge XX.

Temperature Tables.

U. S. National Museum.—Reports 1887, '88.—Proceedings 1887,
'88.

Bureau of Ethnology.—Report 1879-80, '80-1, '81-2, '82-3,
'83-4, '84-5.

Squier and Davis—Ancient Monuments of the Mississippi Valley.

United States Bureau of Education.—Report 1874, '81, '82-3.

Commissioner of Education.—Report 1875, '81.

Department of Agricultural.—Report 1863, '64, '65, '67, '68, '72,
'85, '87.

Bureau of Animal Industry—Report 1886.

Fish Commission.—Report of 1880, '82, '86, '87.

Bulletin 1888, '89, Vol. II '82, III '83.

Fish Industries, Sections III, V Vol. I, V Vol. II, V plates.

Propagation of Food Fishes.—Report 1873-5, '75-6, '81, '82.

Coast Survey.—Report 1853, '54, '55, '71, '74.

Geological Survey.—Rocky Mountain Region, V.

Territories, III book I; XI; 1878 Pt. I, II, Maps.

Annual Reports, 4th ('82-3), 7th ('85-6), 8th ('86-7), 8th Pt. I, 8th
Pt. II, 9th ('87-8), 9th Pt. I, 9th Pt. II, 10th ('88-9.)

Monographs, I, II, III, IV, V, VI, VII, VIII, IX, X, XII,
XIII, XIV, XV Pt. I, XV Pt. II, XVI.

Mineral Resources 1868, '72, '82, '83-4, '86, '87, '88, 89-90.

Patent Office.—Reports 1847; '48; '49-'50 Agl.; '50-'1 Agl.; '51
Agl.; 52-3 Agl.; '53 Pt. 2; Agl.; '54; '54 Agl.; '55 Agl.;
'55 Mechanics; Vol I, II; '56; '56 Agl.; '57 Agl.; '58
Agl.; '58 Agl.; '60 Agl.; '61 Agl.; '70.

- Senate and House Documents.—U. S. and Mexican Boundary Vol. I.
 Explorations and Surveys for Railroad Route—Mississippi to
 Pacific, I, *II, *III, *IV, *V, VI†, VII†, VIII†, IX, X,
 XI.
 Health Officer, District of Columbia.—Report 1881.
 Commissioner Gen'l.—Land Office.—Report 1866.
 Ninth Census,—Vital Statistics †.
 Popular and Social Statistics †.
 Board of Indian Commissioners.—3d Annual Report, 1871.
 Report upon Forestry, 1877.
 Chief Signal Officer.—Reports 1872, '80.
 Consular Reports.—Cattle and Dairy Farming.—Pt. I.
 U. S. Japan Expedition, Vol. I, 1856.
 National Board of Health.—Report 1879.
 Geological Survey of Wisconsin, Iowa and Minnesota.—Owens, 1852.

PAMPHLETS, ETC.

- American Antiquarian.—Vol. I (No. 3 missing), II (No 2 missing),
 III (No. 2 missing).
 American Association for Advancement of Science.—Proceedings
 Vol. V, XXX to XL, XLII.
 American Gardening.—Vol. IX No. 5; XII No. 1, 2; XIII 4, 6;
 XIV 4, 5.
 American Geologist.—Vol. I, No. 1; II, No. 3; IV, No. 1.
 American Journal of Science.—First Series, Vol. I, No. 3, 4; VI to
 X; XV No. 1; XVIII to XXI; XXV No. 1; XXVIII No. 1;
 XXXVIII No. 1; XL No. 2; XLI No. 2; XLII to XLV; XLVII.
 Second Series Vol. I to XIX, XX No. 58, XXII, XXVII,
 XXVIII, XXIX No. 86 and 87, XXX, XXXI, XXXII No.
 94, XLII No. 124 and 126.
 American Meteorological Journal.—Vol. II No. 1 to 8, 10 to 12; III
 No. 1 to 8, 10 to 12; IV. No. 1, 2, 4 to 10, 11; IX No. 1.
 American Monthly Microscopical Journal.—Vol. IX No. 1, XIII No.
 6 to 12, XIV No. 9, XV No. 1.

Bound Volumes. All are bound in cloth unless otherwise indicated. Books
 marked * can be had in half leather or cloth, when marked † in half leather only.

- American Museum of Natural History.—Bulletin Vol. II, Pt. 3; III pp. 195-210; III Pt. 2; IV pp. 81-128; V.
- American Naturalist.—Vol. I to IV, XVII No. 324, XXIII, July.
- American Philosophical Society.—Proceedings Vol. XV, XVI No. 49, XXVII, XXVIII.
- Auk, The.—Vol. X No. 3.
- California Academy of Science.—Bulletin Vol. I No. 1 to 4; II No. 5.
- Chicago Academy of Sciences.—Bulletin Vol. I, No. 1 to 6.
- Colorado College Scientific Society.—Annual Publication, 2d, 3d, 5th.
- Columbus Horticultural Society.—Journal Vol. II No. 10, VIII.
- Entomologica Americana, Vol. II No. 12.
- Indian Museum Notes.—Vol. II No. 1 to 5.
- Journal of Comparative Medicine and Veterinary Archives.—Vol. XIII No. 1 and 11, XV No. 7.
- Journal of Comparative Neurology.—Vol. III pp. 107 to 162.
- Kansas Agricultural College, Experiment Station.—Bulletin No. 46 and 47.
- Kansas University Quarterly.—Vol. II No. 1.
- Kentucky Agricultural Experiment Station, Bulletin 31 and 40. Annual Report 2d.
- Maryland Academy of Sciences.—1888, pp. 33 to 40; 1889, pp. 41 to 44; 1889, 45 to 68.
- Michigan Agricultural College.—Experiment Station Bulletin No. 96.
- Microscope, The.—New Series, Vol. I, No. 3.
- Minnesota Geological and Natural History Survey.—Annual Reports 13th, 14th, 16th.
- Museum of Comparative Zoology.—Annual Reports 1879-80 to 1883-4.
- National Academy of Sciences.—Vol. IV, 10th Memoir.
- Nautilus, The.—Vol. III No. 1, VII No. 5, VIII No. 5.
- Newport Natural History Society.—Proceedings 1883-4.
- Ohio Agricultural Experiment Station, Bulletin.—Technical Series, Vol. I No. 1. Annual Report 1st (1882.)
- Ohio Mechanics Institute.—Scientific Proceedings, Vol II, No. 1, 2.
- Ohio Meteorological Bureau.—Annual Reports, 1st, 3rd, 4th, 6th, 7th, 9th.

Ohio State Board of Agriculture.—Reports 4th (1849), 5th ('50), 7th ('52).

Ohio Weather and Crop Service.—Annual Reports 10th (1892).
Monthly Reports, 1892 May to November.

Ornithologist and Oologist, The.—Vol. XIII, No. 6.

Popular Science News.—Vol. XXVIII, No. 8, 11, 12.

Psyche.—Vol. I, No. 22.

Science.—Vol. I, No. 1 to 21; II, No. 27 to 28; VII, No. 154; VIII, No. 185; X, No. 244; XII, No. 293 to 300, 302, 303.

Smithsonian Institute.

Miscellaneous Collections.—Articles 200, 316, 785.

Catalogue of Lepidoptera, J. G. Morris, 1860.

“ “ Coleoptera, Haldeman and Le Conte.

“ “ Diptera, R. O. Sacken.

Monograph of Diptera, R. O. Sacken.

Catalogue of Society Publications in Smithsonian Institution, 1866.

Bureau of Ethnology.—Annual Report, 4th.

Bibliography of Iroquoian Language.

“ “ Muskahogean “

“ “ Eskimo “

Circular, Square and Octagonal Earthworks of Ohio.

Perforated Stones of California.

Use of Gold and other Metals.

Technical Society of the Pacific Coast, Transactions.—Vol. II, pp. 179 to 205; VI, pp. 51 to 66.

Torrey Botanical Club.—Bulletin, Vol. XIII, No. 3, 5; XIV, No. 1; XVI, No. 7; XVII, No. 9; XIX, No. 3; XX, No. 3.

United States Bureau of Education.

Bulletin 1890, No. 1.

Circulars of Information, 1890, No. 1, 3.

Report on Libraries, 2nd Edition. Pt. II.

United States Department of Agriculture.

Secretary of.—Reports, 1889 to 1891.

Commissioner of.—Reports, 1888.

Division of Botany, Bulletin No. 5.

United States Department of Agriculture--continued.

Division of Entomology.—Bulletin No. 20, 26, 27, 29.

Insect Life, Vol. I, No. 1; V, No. 1,
2, 4.

Division of Economic Ornithology and Mammalogy. Circular
No. 8.

Division of Forestry.—Bulletin No. 3, 5.

“ “ Statistics. Reports.—New Series, No. 50, 55, 80,
80, 81, 111. New Series Miscellaneous No. 1. Special No.
20.

Division of Vegetable Pathology.—Bulletin No. 1. Circular No.
10. Journal of Mycology, Vol. I. No. 1 and 8; VI, No. 11.
Farmers' Bulletins No. 4, 5, 12.

Office of Experiment Stations. Record Vol. V, No. 5.

United States Fish Commission. Bulletin Vol. VII.

Extracts from Bulletin No. 135, 136, 137, 138, 139, 205, 207,
and pp. 371 and 383 of Vol. IX.

United States Geological Survey. Bulletin Vol. IV, V. No. 47 to
58, 60 to 67, 69 to 78, 80 to 84, 97 to 117.

Of Territories. U. S. Entomological Commission. Bulletin
No. 1.

Of Rocky Mountain Region. Contributions to N. A. Ethnology.

United States Consular Reports.—No. 13, 21, 22, 24, 26, 26½, 27,
35, 42, 43, 48, 49, 50, 57, 58, 60, 62, 64, 65, 67 to 70, 73,
74, 83, 88.

Cholera in Europe, 1884.

Trade Guilds of Europe.

Declared Exports, 1884.

Labor in Europe.

The Licoric Plant.

University Studies.—(University of Nebraska,) Vol. I, No. 3.

Washburn College Laboratory of Natural History.—Bulletin, Vol. I
No. 4.

West American Scientist.—Vol. VI, No. 47.

Extras from the Journal of the Cincinnati Society of Natural History.

Development in the Dark Room, T. B. Collier.

In Memoriam of W. A. Dun.

Fossils of the Cincinnati Group, J. F. James.

Catalogues of collections of the Society.

Coleoptera.

Mollusca.

Mammalia, Pt. 1 and 2.

Books and Pamphlets.

Papers by T. H. Aldrich.

“ “ A. P. Morgan.

Computing Aztec Time, J. W. Albert.

Supposed Fossil Fungus of the Coal Measures, J. F. James.

Index to Journal, Vol. I to X.

All communications concerning the purchase or exchange of any of foregoing publications, or subscriptions for the Journal, should be addressed to

THE LIBRARIAN,

CINCINNATI SOCIETY OF NATURAL HISTORY,

312 BROADWAY,

CINCINNATI, OHIO.

REPORT OF TRUSTEES.

THE CINCINNATI SOCIETY OF NATURAL HISTORY.

TO THE BOARD OF DIRECTORS.

Gentlemen:—The undersigned, Trustees of The Society of Natural History, beg leave to submit their report for the year ending April 1, 1895, and state that there has been no change in the investments of the funds of the Society as shown by their report of April 3, 1894, except as stated below, namely:

The demand loan to S. H. Wilder was paid soon after the last report of the Trustees, and was loaned to Samuel Pennywitt, for a term of three years.

The last annual report of the Trustees showed on hand, uninvested, \$3,000 00

Since that report, there have been paid in:

The Shields loan for.....	4,000 00
The Bender loan for.....	2,000 00
TOTAL,.....	\$9,000 00

This fund has been re-invested, all security satisfactory to the Trustees. The principal in each case being payable in Gold Dollars, as follows:

To John Bender for term of five years.....	\$2,000 00
To Wm. Mitchell for term of three years.....	2,000 00
To Philip Grandin for term of five years.....	3,000 00
To John P. Grandin for term of five years.....	2,000 00
TOTAL.....	\$9,000 00

It will be noticed that the loan to Bender was made and paid back to the Society since the last report.

The principal of the Blymyer loan has not been paid, but the interest is paid promptly. Through the indorsement of Mr. F. A. Schmidt, and the present status the loan is satisfactory to the Trustees.

So far as the Trustees are informed, the interest on all of the loans has been paid with a high degree of promptness during the last year.

Dr. Bigney has been absent a portion of the time in the pursuit of health, but his co-trustee is informed that the Dr.'s health is improving, and that he will return probably in the near future. He has, however, given all needed attention to the administration of the trust, so that the interests of the Society have in no way suffered from his absence. It requires the concurrence of both Trustees to negotiate a loan.

The Trustees would suggest the importance of an annual inspection of the loans made by the Trustees, and of the securities held by them. It is believed that no examination was made last year. We think it a wise policy that requires an annual examination, no matter who the Trustees may be, and we request that you appoint such a committee at your annual meeting.

Respectfully submitted,

AARON A. FERRIS,

Trustee.

CINCINNATI, O., March 26 1895.

REPORT OF TREASURER.

CINCINNATI, O., April 2, 1895.

TO THE PRESIDENT AND MEMBERS OF THE CINCINNATI SOCIETY
OF NATURAL HISTORY.

Attached hereto, I present my report of the receipts and disbursements for the current year just finished, showing cash balance on hand at this date of \$356.51.

The interest due the Society on loans made by the Trustees of funds belonging to the Society, has been paid up to date, and considering the condition of the times, has been as promptly met as could be expected.

The Treasurer, by authority of the Board, has paid interest on all the Society's outstanding obligations, as they matured.

None of the obligations of the Society, amounting to \$2,100, have been paid during the past year, and as they will begin to mature in June, 1896, I feel constrained to urge upon the Society the necessity of promptly making some provision for their payment or renewal.

RECEIPTS.

Balance on hand April 1st, 1894.....	\$ 329 90
Interest received from loans.....	2,470 75
Dues to the Society.....	305 00
Received from sale of Journals.....	32 50
Received from sale of furniture.....	10 50
TOTAL.....	\$3,148 65

DISBURSEMENTS.

Paid for labor and salaries.....	\$1,551 80
“ “ publication of the Journal.....	473 65
“ “ fuel.....	38 75
“ “ postage.....	11 75
“ “ Custodian's sundries.....	125 00
“ on account of Photographic Section.....	16 00
“ for street sprinkling	12 00
“ for interest on bonds.....	124 25*
“ on account of lectures.....	11 00
“ for printing and stationery.....	42 54
“ for repairs, etc.....	69 78
“ on account of Museum.....	255 39
“ water rent.....	25 00
“ for gas.....	24 10
“ on account of fixtures.....	11 13
TOTAL.....	\$2,792 14
BALANCE.....	\$ 356 51

Very respectfully submitted,

T. B. COLLIER,
Treasurer.

REPORT OF CURATOR OF PHOTOGRAPHIC SECTION.

TO THE EXECUTIVE BOARD CINCINNATI SOCIETY OF NATURAL HISTORY.

Gentlemen:—In making my report as Curator of Photography for the past year, I desire to say that the Photographic Section has about held its own in spite of the hard times. There have been some gains

*This includes \$1.25 protest fees on one of the interest notes due the Society, which was afterwards paid, and credit given to account of interest from loans, and is included in the item of \$2,470.75 of receipts.

and some losses in membership, but in point of numbers we stand, practically, where we did one year ago.

The interest in the subject of photography has been maintained fairly well; much good work has been done by members of the Section.

A series of six special entertainments, in charge of as many different committees, were given in our lecture-room within the past winter and each succeeding committee seemed to strive to excel all others. The result was eminently satisfactory to the Section in every way.

The Section decided last October to discontinue its connection with The American Lantern Slide Interchange, for the reason that the interest in this particular branch of work seemed to be decreasing on account of too frequent exhibitions of lantern slides.

The Section gave its annual exhibition of lantern slides at the Pike Opera House, on the evening of April 20th, 1894.

The work then exhibited by the members was up to the standard and it was cordially received by the audience in attendance.

The annual outing of the Section took place on the 30th of May, 1894. The forenoon of that day proved to be rainy and disagreeable, but later on, the clouds cleared away and some excellent photographic work was done. The committee took us to Delhi, O., as the objective point of the outing, and Mr. and Mrs. E. A. Belden, of that place, threw open their commodious and elegant home to the Section and its friends in a way that none will ever forget. Their uniform courtesy and kindness call for this special recognition.

Your Curator desires to direct especial attention to a matter that that the Board should consider. All the hot water used in cleaning and scrubbing about our building, is heated on a small gas stove in the operating rooms of the Section. It does not seem the proper place to have such work done; and the condition of the operating rooms at various times in regard to dirt and unpleasant odors is thought to have its origin in the indiscriminate use of this gas stove which is only intended to be used in a limited way by members to heat water for the mixing of their chemicals.

Trusting that you may be able to devise some plan to abate this nuisance, I will offer no further recommendations.

Respectfully submitted,

H. J. BUNTIN,

Curator of Photography.

REPORT UPON INVESTMENTS AND SECURITIES.

CINCINNATI, O., May 3rd, 1895.

TO THE CINCINNATI SOCIETY OF NATURAL HISTORY:

Gentlemen:—The undersigned one of a committee consisting of the President and Treasurer, appointed at the annual meeting to inspect the securities belonging to the Endowment fund, now in the hands of the Trustees of the Society, report as follows:

That he met Mr. A. A. Ferris at the Merchants National Bank, where the papers are deposited, and upon examination found them to be as described below:

1st.	Cincinnati Southern Railway Bonds at $7\frac{3}{10}$ interest.....	\$2,000
2nd.	Mortgage, Martin Byrnes.....	4,000
	Insurance payable to the Society, \$2,000.	
3rd.	Mortgage, Clara M. Baker, et al.....	1,500
4th.	Mortgage, Caroline Blymyer, et al.....	8,000
5th.	Mortgage, Mary S. Orange.....	2,000
6th.	Mortgage, John A. Biglow.....	1,000
7th.	Cincinnati Deficiency Bond.....	500
8th.	Cincinnati Deficiency Bond.....	100
9th.	Alvin Knop.....	6,000
	Insurance, \$5,000.	
10th.	Harry Falquett.....	2,100
	Insurance, \$1,500.	
11th.	Hester Froome.....	500
12th.	John S. Dempsey.....	2,000
13th.	One Procter & Gamble Co. Bond.....	1,000
14th.	Cincinnati Street R. R. stock certificate for 8 shares in name of the Society.....	400
15th.	Fred. A. Schmidt, Mortgage.....	2,000
16th.	Mortgage, Samuel Pennywitt.....	1,000
17th.	Mortgage, Wm. Mitchell.....	2,000
	Insurance, \$800.	
18th.	Mortgage, Philip Grandin.....	3,000
19th.	Mortgage, John P. Grandin.....	2,000
Total		\$41,100

Some of the mortgages are overdue, but I am informed that the interest is paid regularly on all.

Owing to a misunderstanding as to the meeting, Mr. Collier was not present.

Respectfully submitted,

DAVIS L. JAMES, *Committee.*

NEW NORTH AMERICAN FUNGI.

BY A. P. MORGAN.

The following genera and species of fungi and myxomycetes from various localities seem to me new and not hitherto described.

(See Plates I, II, III. The figures on these plates are numbered to correspond with the numbers of the species, the letters are explained in detail under "Explanation of Plate.")

1. *BOLBITIUS RADIANUS*.—Pileus fleshy-membranaceous, convex then expanded and depressed, sulcate, viscid, pale pinkish or ferruginous, growing darker. Stipe more or less elongated, tapering upward, hollow, flocculose, white. Lamellæ free, ferruginous. Spores ferruginous elliptic, 12-14x8 mic.

Growing on old straw, horse manure, etc. Canada *Dearness*; Ohio, *Morgan*. Pileus 4-6 cm. in diameter, the stipe 6-10 cm. in length. The delicate pellicle on the pileus breaks up into scales on the disk and splits into fibers along the furrows; these extend more than half way from the margin. The habit is quite different from that of *Agaricus* (*Galera*) *lateritius*. Fr.

2. *MARASMIUS MELANOPUS*.—Pileus membranaceous, convex, glabrous, not striate, purplish-gray. Stipe slender, hollow, glabrous, black, smooth, polished and shining. Lamellæ adnate, somewhat distant, rather broad, purplish-gray. Spores obovoid, apiculate, 5-6x2.5 mic.

Institious on old leaves, late in autumn. Preston, Ohio. Pileus 4-6 mm. in diameter, the stipe 2-4 cm. in length. Both the pileus and the lamellæ are of the same uniform substance and color; the black polished stipe does not become paler at the apex.

LENTODIUM, GEN. NOV.

Pileus fleshy-coriaceous, tough, hard when dry, persistent. Stipe more or less elongated, tough, central or eccentric, confluent with the hymenophore. Hymenium porose-cellulose, the lower surface veiled by a thick persistent membrane, which is at length radiately dehiscent. Spores white.

A genus of the Agaricini quite remarkable for the peculiar structure of the hymenium, which very much resembles that of

Secotium among the Gastromycetes. I should place it next to *Lentinus*.

3. *LENTODIUM SQUAMULOSUM*.—Pileus fleshy-coriaceous, orbicular, more or less irregular, thin, umbilicate, covered with small appressed hairy scales, gray or rufous to blackish in color. Stipe tough, solid, scaly as the pileus, central or eccentric, short or elongated, often more or less deformed. Hymenium a thick stratum of irregular pores descending from the hymenophore and adnate to the stipe; the pores branch and anastomose, are traversed by veins and divided into cells by cross-partitions. The lower surface of the hymenium is closed by a thick white floccose membrane, which after maturity splits irregularly in a radiate manner. Spores white, elliptic-oblong, $5.6 \times 2\frac{1}{2}$ -3 mic.

Growing on old logs and stumps. Pileus 2-5 cm. in diameter and about a centimeter in thickness, the stipe various in length sometimes very short. The first mention of this curious production is in Lea's Catalogue in which it is considered an abnormal form of *Lentinus tigrinus*, Bull. It is referred to again in Berkeley's Notices under No. 104. I meet with this fungus nearly every season and it always has the form above described. I have never found a specimen of *Lentinus tigrinus* in this region and I have no information that the present fungus has ever occurred in Europe. I am of the opinion that it is a perfectly normal production; if not the normal and abnormal condition must at sometime occur together and the abnormal form must be accounted for.

4. *POLYPORUS CIRCUMSTANS*.—Pileus hard and woody, pulvinate to ungulate, thick, more or less encircling the stem; the surface brown or blackish, rough, concentrically furrowed; the pores very long, minute, rotund, white within and without. Spores oblong, even, hyaline, 6.7×4.5 mic.

Growing on *Shepherdia argentea* Nutt. in South Dakota, Prof. Thomas A. Williams. Pileus 4-8 cm. in width and 2-5 cm. in height or thickness, seated upon the upright stem or branch and sometimes encircling it half way or more. The substance of the pileus is nearly all the white or slightly discolored tubules which are indistinctly stratified; these are protected on the upper sloping surface by a thin brown crust much roughened and usually with several concentric furrows. The nearest relative growing in this country is *Polyporus pinicola*, Fr.

5. *HYDNUM ATROVIRIDE*.—Dark green in color throughout. Pileus fleshy-coriaceous, thin, convex then expanded, orbicular or somewhat irregular, glabrous. Stipe more or less deformed, short or elongated, central or eccentric. Aculei slender, acute. Spores dark green, rough and irregular, 6-9 mic. in diameter.

Growing on old wood. Auburn, Ala., *Prof. George F. Atkinson*. Pileus 1-2 cm. in diameter, the stipe 1-2 cm. in length. It is easily recognized by the dark green color in every part, even of the spores.

ASTEROSTROMA, MASSEE.

Resupinate-effused; subiculum fibrillose, dry, with intermingled brown stellate hyphæ. Spores white, hyaline. Allied to *Corticium*, but readily distinguished by the brown stellate hyphæ present in the subiculum. *Journal of the Linnean Society, Vol. XXV, p. 154.*

Mr. Masee's genus is established with six species, five of them from America. The following species sent by Prof. McClatchie from California, is quite distinct from any of those described by Masee.

6. *ASTEROSTROMA PALLIDUM*.—Effused, closely agglutinate, smooth, pallid, the margin entire; subiculum of slender hyaline fibrils with abundant intermingled brown stellate threads. Spores hyaline, globose, with a few delicate spinules, 6-7 mic. in diameter.

Growing on old wood and effused for several centimeters. California, *Prof. A. J. McClatchie*. The rays of the stellate hyphæ are 4-6 in number and simple, or sometimes with a branch or two; they are elongated and acute, measuring 40-60 mic. in length.

7. *GEASTER VELUTINUS*.—Mycelium fibrous, rooting from the base. Outer peridium externally invested with a dense minute gray pubescence, splitting into 5-7 acute segments, the inner fleshy layer thin, easily separable but persistent. Inner peridium globose, sessile, smooth, pallid; the mouth conic, ciliate-fimbriate, seated in a circular area. Columella subclavate, reaching the center; threads of the capillitium once or twice as thick as the spores, pale brown; spores globose, even, pale brown, $2\frac{1}{2}$ -3 mic. in diameter.

Growing on the ground. Columbia, S. C., *Prof. George F. Atkinson*. Inner peridium about 1 cm. in diameter, the segments expanding to 3-4 cm. Peculiarly distinguished by its gray pubescent outer surface.

8. *CALVATIA LEIOSPORA*.—Peridium large, oblong-obovoid, with a thick base plicate below and a cord like root. Cortex a smooth continuous layer, very thin and fragile, whitish, reticulately marked; inner peridium thickish but fragile, velvety, ochraceous, after maturity the upper part soon breaking up into fragments and falling away. Subgleba occupying about one half of the peridium, convex above, ochraceous in color; mass of spores and capillitium violaceous to livid; the threads very long, scarcely so thick as the spores, sparingly branched; spores globose, even, $3\frac{1}{2}$ -4 mic. in diameter.

Growing on the prairies, South Dakota., Prof. Thomas A. Williams. Peridium 6-9 cm. in height and 4-6 cm. in diameter. The ochraceous inner coat and subgleba contrast quite peculiarly with the violaceous capillitium and spores.

9. *CALVATIA HESPERIA*.—Peridium sub-globose or obovoid, more or less irregular, with a thick cord-like root. Cortex a smooth white coat apparently inseparable from the inner peridium; the two together forming a thick tough rigid peridium, a long time persistent and finally dehiscent by an irregular torn aperture. Subgleba obsolete; mass of spores and capillitium compact and firm, clay-color, greenish yellow to ochraceous; the threads very long, scarcely branched, remotely septate and breaking easily at the septa, from once to twice the thickness of the spores. Spores globose or oval, even, 4-5 mic. in diameter, often with a minute pedicel.

Growing in sandy soil; Pasadena, California, Prof. A. J. McClatchie. Peridium irregular in shape, and quite variable in size very different threads. It most resembles *Bovista pila* B. & C., but has 4-8 cm. in diameter. The peridium is thick, tough, and persistent; with more than a dozen specimens I could not find that it was at any stage separable into two coats. Prof. McClatchie says it is edible.

10. *LYCOPERDON DRYINUM*.—Peridium globose, sessile, with a fibrous mycelium. Cortex a thin coat of small white scales sometimes tinged with brown, these dry up into minute persistent brown or blackish warts on the smooth shining surface of the inner peridium. Subgleba obsolete; mass of spores and capillitium greenish-yellow then brownish-olivaceous; the threads much branched, the main stem about as thick as the spores, the branches long and tapering; spores globose, even, $3\frac{1}{2}$ -4 mic. in diameter, often with a minute pedicel.

Growing on the old leaves in oak woods; usually solitary. Preston, Ohio. Peridium about one centimeter in diameter. This is a very pretty little puff ball which has a curious way of growing here and there, one in a place, among the old leaves in the thick woods. After maturity the shining peridium exhibits various tints of yellow, coppery and bronze. It is much more delicate than *L. pusillum* and has a very different habit.

11. *RETICULARIA NITENS*.—*Æthidium* pulvinate, variable in shape and size, inclosed by a thin fragile black and shining membrane. Walls of the sporangia black and shining, fibrous thickened and grown together, more persistent below, after maturity the membrane rapidly disintegrating, leaving behind a loose irregular network of bands, fibers and threads. Spores globose, minutely warted, brown, 9-10 mic. in diameter.

Growing on old bark. Pasadena, California, *Prof. A. J. McClatchie*. *Æthidium* 2 or 3 centimeters in extent. It differs from *Reticularia atra* more particularly, in the spores being much smaller and more coarsely warted.

12. *HEMIARCYRIA MONTANA*.—Sporangium globose or obovoid, olive-yellow, sessile or substipitate; the wall minutely reticulate within, externally smooth and shining, breaking up irregularly, the upper part gradually falling away. Stipe very short or obsolete, arising from a thin hypothallus. Capillitium of threads 6-8 mic. in thickness, repeatedly branched and anastomosing to form a dense network with many short free extremities next the wall, olive-yellow in color; the spiral ridges four or five, close or sometimes lax and often with minute scattered spinules. Spores olive-yellow, globose, very minutely warted 11-13 mic. in diameter.

Growing gregariously on old wood, at an altitude of 7,400 feet in the San Bernadino mountains of California; *S. B. Parish*. Sporangium 1-1.5 mm. in height, the stipe usually shortened to a mere point. An elegant species readily distinguished by its large spores, belonging to the section *Arcyrioides*.

13. *LYCOGALA REPLETUM*.—*Æthidium* large, pulvinate, the surface dull gray with minute brown spots, irregularly dehiscent. The wall thick and firm, becoming rigid, a cellulose structure of brownish vesicles. From the inner membrane proceed broad, flat expansions, which traverse the interior, are often perforated and give out on all

sides short free clavate tubules, attended by very fine long branched threads. Spores in the mass cinereous, globose, minutely warted, 6-7 mic. in diameter.

Growing on the ground, San Bernadino, California; *S. B. Parish*. *Æthaliu* 4-7 cm. in diameter, the short blunt extremities extremely variable in size, the fine threads scarcely more than 1-2 mic. in thickness. The internal structure of this *Lycogala* is very similar to that of *Reticularia* except the short clavate branches which correspond to the tubules in the other species. The spores under high magnification are reticulate as in the other species.

ARGYNNA, GEN. NOV.

Perithecia superficial, carbonaceous, sub-globose, naked, astomous, breaking up irregularly. Asci ———. Sporidia fuliginous, uniseptate, papilionaceous.

A genus characterized by its peculiarly shaped sporidia. Although I can find no asci in the well matured specimen, I am disposed to think the fungus belongs among the Perisporiaceae, and that when an earlier stage is met with the asci will be found. I can discover no other way by which the sporidia can have been produced, and therefore, I assume that the asci have disappeared.

14. ARGYNNA POLYÆDRON.—*Physarum polyædron*, Schw. N. A. Fungi, No. 2300. Perithecia subglobose, gregarious, dull black, rather large, sessile on a broad base, becoming polyhedral and at length rupturing along the edges into polygonal fragments, which gradually fall away. Sporidia sooty-black, uniseptate, butterfly-shaped, 6-8x4-5 mic.

Found inside a hollow hickory log which was split open for firewood. Perithecia 1-1.5 mm. in diameter. This singular fungus has not before been recorded since the time of Schweinitz. Of course it cannot be conceded that it belongs to the Myxomycetes by reason of its uniseptate sporidia and on account of its structure generally. Long branched threads issue from the inner surface of the wall and mingle with the sporidia, but when cleared of the adherent sporidia they are seen to be very delicate hyaline threads scarcely 1 mic. in thickness, with no suggestion of having borne the sporidia. I am indebted to Dr. George A. Rex for having identified my material with the specimen of de Schweinitz in the herbarium of the Philadelphia Academy of Sciences.

PYRENOMYXA, GEN. NOV.

Stroma superficial, pulvinate, the substance black and carbonaceous, composed mostly of large confluent cells (perithecia?) with thin fragile walls, their large mouths covered by a uniform continuous layer. Asci——. Sporidia navicular, brown, continuous, produced in spherical or oval clusters of 8, lying edge to edge.

I can furnish no theory for the production of the spores other than that they are formed in asci; and if this be true, it appears to me the genus will be most nearly related to the genera *Bolinia* and *Ustulina* of the *Pyrenomycetes*. I have waited several years to find the younger stage of the fungus but it has not appeared and it is hoped this publication may enable others to find it.

15. *PYRENOMYXA INVOCANS*.—Stroma pulvinate, more or less elongated and irregular, internally black, the outer surface ochraceous. Cells (Perithecia?) very large, oblong, in two or three irregular layers, to some extent confluent, crowded and compressed, their walls thin and fragile; the wide mouths with crenulate margins, closed by a thin fragile common crust. Sporidia brown, navicular, thin 12-15x4-6 mic.

Growing on hard wood of hickory. Preston, Ohio. Stroma 2 or 3 to several centimeters in extent and about 5 mm. in thickness. I first found this singular fungus about twelve years ago. The first specimens lay around a long time and were finally thrown away as something abnormal and worthless. Three or four years ago I found it again and in a locality distant many miles from the first place. Portions of the second collection have been distributed to several mycologists. It has been suggested that the organism belongs to the *Myxomycetes* and in fact the stroma with its large cells greatly resembles the æthalioid form of *Tubulina cylindrica*, Bull.

16. *MITRULA ROSEOLA*.—Ascoma capitate, stipitate; the head globose or obovoid, continuous with the stipe, pale pinkish, internally stuffed with white fibers; stipe short, thick, erect, solid, white. Asci elongated-clavate, 60-80x7-8 mic. with a short stalk; paraphyses filiform. Sporidia subdistichous, clavate-cylindric, hyaline, continuous, 20-25x2.5 mic.

Growing on sandy soil, Columbia, S. C. Prof. George F.

Atkinson. No. 956. 4-8 mm. in height, the head 2-4 mm. in diameter. A small species well distinguished by its globular head continuous with the stipe.

17. *PEZIZA NIGRANS*.—Ascoma at first cupulate and orbicular, becoming explanate and more or less irregular, externally smoky-pallid and glabrous, attached to the soil by slender fibers; the hymenium black. Asci cylindric, 8-sporous, the upper part containing the sporidia 60-70x10 mic., shorter than the lower empty portion; paraphyses filiform, with clavate apices. Sporidia uniseriate, globose, coarsely warted, smoky hyaline, 8-9 mic. in diameter.

Growing on burnt soil; in autumn; Preston, Ohio Ascoma 1-2 cm. in extent, more or less irregular in outline. Belonging to the genus *Detonia* of Saccardo's *Sylloge*; closely akin to *Peziza trachycarpa*, Currey. The dark granular coloring matter of the hymenium closely cements the asci and paraphyses together; there are 15 to 20 warts on the surface of each sporidium.

18. *SCLERODERRIS RUBRA*.—Ascomata gregarious erumpent, becoming superficial and cupulate, coriaceous, the outer surface brown and furfuraceous; the hymenium red, changing to brown with age. Asci cylindric, 8-sporous, 130-150x12-15 mic., the stalk very short; paraphyses abundant, filiform, overtopping the asci. Sporidia obliquely uniseriate, oblong, brown, 3-septate, constricted at the septa, the cells nucleate, 20-30x8-10 mic.

Growing on dead branches of *Asimina triloba*. Ascoma 2-3 mm. in extent when fully developed. The apices of the paraphyses are glued together by a red granulose coloring matter to form the surface of the hymenium. The *Scleroderris* is accompanied on the same branches by a *Cenangium* with oblong hyaline continuous sporidia of about the same size.

19. *TRIPOSPORIUM BICORNE*. — Hyphæ slender, creeping, septate, brown, sending up here and there fertile branches, which bear at the apex a single spore. Sporophore ascending or erect, variable in length and not so thick as the spore, with a few distant septa. Spore consisting of a short basal segment with two widely divergent branches, one branch 4-6 septate and 40-60 mic. in length; the other 5-7 septate and 70-75 mic. in length; the base of the spore 8-10 mic. in diameter, each branch at the lower septum 11-14 mic. in thickness and tapering gradually to a blunt point.

Running over and apparently parasitic upon *Diplodia Zeae*, Schw. on old cornstalks. One horn of the spore nearly always has one septum less and is, therefore, one segment shorter than the other horn.

20. *MONOTOSPORA NIGRA*.—Effused, thin, black; the hyphæ long, slender, flexuous, brown, septate, branched, with numerous fertile branches, bearing a single spore at the apex. Sporophore more or less elongated, sometimes very short, ascending or erect; the spore globose or obovoid, smooth, black, opaque, usually with a short brown pedicel, 14-18 mic. in diameter, the pedicel 4-6 mic. in length.

Growing on old cornstalks, Preston, Ohio. As in other species there is sometimes on the sporophore a short lateral branch below the apex bearing another spore.

21. *ACROTHECIUM RECURVATUM*.—Effused in a thin brown stratum. Fertile hyphæ long, slender, erect, septate, brown, arising from very fine threads creeping on or within the matrix and scarcely visible, each bearing several spores at the apex in a short helicoid cyme. Spores oblong or oblanceolate, 3-septate, hyaline, borne on minute blunt teeth of the recurved hyaline rachis, 25-30x7-8 mic.

Growing on old wood, Preston, Ohio. This differs from all other species of the genus in the peculiar one-sided arrangement of the spores; there are sometimes a dozen or more in the recurved spike.

22. *STREPTOTHRIX CINEREA*.—At first in small white tufts or pulvilli, then at length by confluence becoming extensively effused and changing in color to cinereous. Hyphæ greatly elongated, intricately much branched, entangled and matted together; the individual threads hyaline, spirally twisted and knotted. Spores sessile everywhere upon the hyphæ, hyaline, globose, 4-6 mic. in diameter.

Growing on old cornstalks in autumn; Preston, Ohio,. The threads are as thick as the diameter of the spores, and are twisted in the same characteristic manner as in the common brown species.

23. *PHYSOSPORA ELEGANS*.—Effused, thin, flocculose, then pulverulent, bright ochraceous; hyphæ long, slender, creeping septate, dilute ochraceous, much branched and interwoven, producing everywhere short, erect, inflated vesicles. These vesicles ellipsoid, obovoid or quite irregular, 14-20x9-12 mic. bearing at the apex usually

two (1-3) spores on short blunt pedicels; spores globose, ochraceous, 16-20 mic. in diameter.

Growing on rotten oak trunks, Preston, Ohio. The hyphæ are remarkable for the clamp-connections which are present at every septum, even next the spores, and when these fall off the clamp-connection persists on the pedicel.

24. MYCOGONE CINEREA.—Effused, thin, at first white and flocculose then cinereous or argillaceous and pulverulent; hyphæ slender, hyaline, branched, intricate, producing the spores at the apex of short lateral branches. Spores composed of two unequal globose cells, the lower and smaller one hyaline and projecting scarcely half way from the larger, sometimes nearly hidden within it, the larger cell cinereous and densely spinulose; whole length of the spore 15-20 mic., diameter of the smaller cell 5.8 mic., of the larger 13-17 mic.

Growing on *Helvella elastica* Bull. The spores are much smaller than in *Mycogone cervina*, Ditm. There appeared on the same threads fusiform hyaline microconidia, 3-septate 18-25x4-5 mic.

REMARKS ON A "CATALOGUE OF OHIO PLANTS"
BY KELLERMAN AND WERNER.

BY JOSEPH F. JAMES, M.D.

This catalogue, undoubtedly the most extensive that has ever been published of Ohio plants, occupies 350 pages (56-406) of part 2 of volume 7 of the Geological Survey of Ohio. It has only recently been distributed, although the title page of the volume is dated 1893. It is scarcely to be expected that so extensive a work as this would be without omissions and errors, and in the belief that any additions to the list would be acceptable the following remarks are offered. Pages 56-79 are taken up with a bibliography extending from 1815 to 1893. One hundred and thirty-three references are given, with short notices of the contents of each article. Within the period mentioned quite a number of omissions have been noted and in addition to these omissions, a small number are here given that have been published between 1893 and 1895.

1845.

Decades of Fungi. By M. J. Berkeley. Decades VIII-X. Australian and North American Fungi. Hooker's Lond. Jour. of Botany, Vol. IV, 1845, pp. 298-315.

This can not be supposed to take the place of the descriptions of fungi given in Lea's Catalogue of plants of Cincinnati. In that publication there are many notes not given in the one under notice, and there are remarks here not given in the catalogue. The descriptions are the same in both, but the names date from this publication and not from the Catalogue. After describing *Agaricus (Clytocybe) ochropurpureus*, Mr. Berkeley says: "This, and the greater part of the following species, are described from a very rich collection of Fungi, consisting of above 280 species, from the neighborhood of Cincinnati, kindly sent to Sir W. J. Hooker, by T. G. Lea, Esq., and accompanied in many instances by very copious and valuable notes. The collection has furnished a large quantity of interesting species, first made known in his memoirs by Schweinitz, some very rare European forms, and a considerable number of new species, the

most important of which are here described. I have myself corresponded on the subject with their discoverer, and can bear witness to his great kindness and zeal; and I have no doubt mycology will be greatly enriched by his labors." Unfortunately Mr. Lea died a short time after this was written.

1847.

Decades of Fungi. Dec. XII-XIV. Ohio Fungi. By M. J. Berkeley. Hooker's Lond. Jour of Bot., Vol. VI, 1847, pp. 312-326.

A continuation of descriptions of new species of fungi collected by Thos. G. Lea and reprinted with some additional notes in Lea's Catalogue of plants, 1849.

1874.

Notes on Botany. By John Hussey. Cin. Quart. Journal Science, Vol. I, 1874, pp. 26-28.

Records occurrence of *Polypodium incanum* in Adams county.

1875.

The *Æcidium-Puccinia* Question. By E. W. Claypole. Cin. Quart. Journal Science, Vol. II, 1875, p. 285.

Mentions occurrence of *Æcidium berberidis?* on *Podophyllum peltatum* followed by a *Puccinia* on the same host plant.

1881.

On the Variability of the Acorns of *Quercus macrocarpa*, Michx. By Jos. F. James. Jour. Cin. Soc. Nat. Hist., Vol. IV, Dec. 1881, pp. 320-322, pl. 1.

Describes differences presented by specimens collected in Hardin county, Ohio, and illustrates them in the plate.

1882.

Notes on *Ambrosia trifida*. By A. F. Foerste. Bot. Gazette, Vol. VII, 1882, p. 40.

Describes method of distribution of seeds by means of frost. The observations were made near Dayton.

Depauperate *Rudbeckia*. By Jos. F. James. Bot. Gazette, Vol. VII, 1882, p. 41.

Describes a specimen of *Rudbeckia hirta* only two inches high, found near Cincinnati.

Aralia racemosa. By Jos. F. James. Bot. Gazette, Vol. VII, 1882, p. 122.

Describes a large specimen of *A. racemosa* found near Cincinnati.

[Plants in bloom on April 4th, 1882.] By J. A. Warder. Jour. Cin. Soc. Nat. Hist., Vol. V, July, 1882, pp. 65-67.

A list of 59 native and 45 cultivated species observed in bloom near Cincinnati, on April 4, 1882. A few were added by D. L. James.

Descriptions of new species of Fungi, collected in the vicinity of Cincinnati, by Thomas G. Lea and described by Rev. M. J. Berkeley. Jour. Cin. Soc. Nat. Hist., Vol. V, Dec. 1882, pp. 197-217.

A reprint of descriptions and notes on fungi, edited by Davis L. James from Lea's Catalogue of plants of Cincinnati, published in 1849.

1883.

The Mycologic Flora of the Miami Valley, O. By A. P. Morgan. Jour. Cin. Soc. Nat. Hist., Vol. VI, April, 1883, pp. 54-81, pl. 4.

This and eight other papers of Mr. Morgan under the same title, are grouped by Kellerman and Werner under one heading. In view of their great value and importance, we have separated them to give the date and pagination of each. Kellerman and Werner state that there are colored plates. This is the case only with the extras distributed by the author. The plates in these are all hand colored by Mrs. Morgan. This section deals with the Leucospori of *Agaricus*.

The same. Ibid., Vol. VI, 1883, pp. 97-117.

This part concludes the genus *Agaricus*.

The same. Ibid., Vol. VI, 1883, pp. 173-199, pl. 1.

This part includes the genera *Coprinus*, *Bolbitius*, *Cortinarius*, *Paxillus*, *Hygrophorus*, *Lactarius*, *Russula*, *Cantharellus*, *Marasmius*, *Lentinus*, *Panus*, *Troglia*, *Schizophyllum* and *Lenzites*.

1884.

The same. Ibid., Vol. VII, 1884, pp. 5-10, pl. 1.

Treats of genus *Boletus*.

New species of Fungi. By Chas. H. Peck. Bull. Torrey Botan. Club, Vol. XI, Mar., 1884, pp. 26-28.

Describes *Polyporus delectans* from Ohio, together with *Myriodoporus adustus* and *Hypomyces xylophilus* mentioned by Kellerman and Werner (p. 68.)

New species of Fungi. By Chas. H. Peck. Bull. Torrey Bot. Club, Vol. XI, May, 1884, pp. 49-50.

Physarum multiplex n. sp. is described from Ohio.

Note on *Viola cucullata*. By Jos. F. James. Bot. Gazette, Vol. IX, July, 1884, p. 113.

Notes large size of flowers and visits of bees with setting of fruit as a result. The observations were made near Cincinnati.

Kansas Fungi. By J. B. Ellis and W. A. Kellerman. Bull. Torr. Bot. Club, Vol. XI, Oct., 1884, pp. 114-116.

Describe new species of fungi among which is *Septoria leptostachya* from Ohio.

1885.

The Mycologic Flora of Miami Valley, Ohio. By A. P. Morgan. Jour. Cin. Soc. Nat. Hist., Vol. VIII, 1885, pp. 91-110, pl. 1.

Deals with species of *Polyporus*.

The same. Ibid., Vol. VIII, pp. 168-174.

Concludes genus *Polyporus* and *Myriadoporus*.

The life in the Tyler-Davidson Fountain [Cincinnati.] By G. B. Twitchell. Jour. Cin. Soc. Nat. Hist., Vol. VIII, Oct., 1885, pp. 166-168.

Mentions species of Diatoms found in the water in the basin and also the filamentous algæ, especially *Stigeoclonium tenue*.

Progress of Vegetation in the Ohio Valley. By Jos. F. James. Jour. Cin. Soc. Nat. Hist., Vol. VIII, 1885, pp. 115-117.

In this paper is given a list of 15 of the earliest flowering plants with dates when first observed in bloom for 8 years. The deduction from the data given was that every alternate year had a backward spring. The even years had early springs, the odd years late springs.

1886.

The Mycologic Flora of the Miami Valley. By A. P. Morgan. Jour. Cin. Soc. Nat. Hist., Vol. IX, 1886, pp. 1-8.

Deals with genera *Trametes*, *Diedalea*, *Favolus*, *Merulius*, *Porothelium* and *Solenia*.

1887.

The same. Ibid., Vol. X, 1887, pp. 7-18.

Deals with the *Hydnei*.

The same. Ibid., Vol. X, 1887, pp. 188-202.

Deals with *Thelephorei*.

1888.

The same. Ibid., Vol. XI, 1888, pp. 86-95, pl. 1.

Deals with *Clavariet* and *Tremellinet*, concluding the Hymenomyces.

Diseased Plums. By Jos. F. James. Bot. Gazette, Vol. XII, July, 1888, p. 193, figure.

Describes effects of *Exoascus pruni* on *Prunus americana* noted near Oxford, Ohio.

1889.

Mucronoporus, E. & E. By J. B. Ellis and B. M. Everhart. Jour. Mycol., Vol. V, June 1889, pp. 90-92.

Refer to *Mucronoporus spissus* (Schw.) as occurring in Ohio.

New and rare species of North American Fungi. By J. B. Ellis and B. M. Everhart. Jour. of Mycol., Vol. V, Sept. 1889, pp. 145-157.

Note *Asochyta cornicola* Sacc., *Cylindrosporium? oculatum* n. sp., and *C. viridis* (?) n. sp., as occurring in Ohio.

North American Fungi. The Gastromycetes. By A. P. Morgan. Jour. Cin. Soc. Nat. Hist., Vol. XI, 1889, pp. 141-149, pl. 1.

Although entitled "North American Fungi" the most of the species herein described occur in Ohio. *Mutinus bovinus* n. sp. is described and illustrated. This is an Ohio species.

North American Fungi. Second paper. By A. P. Morgan. Jour. Cin. Soc. Nat. Hist., Vol. XII, 1889, pp. 8-22, pl. 2.

Contains descriptions of species of *Lycoperdaceæ*, many of them from Ohio.

1890.

North American Fungi. Third paper. Lycoperdaceæ continued. By A. P. Morgan. Jour. Cin. Soc. Nat. Hist., Vol. XII, 1890, pp. 163-172, pl. 1.

Describes *Tylostoma verrucosum* n. sp., and several other species, not new, occurring in Ohio.

Report on the extent, severity and treatment of Black rot and Brown rot [of the grape] in Northern Ohio in 1889. By F. L. Scribner. Bull. No. 11, Section of Veg. Pathology U. S. Dept. Agric. 1890, pp. 76-83.

Discusses the ravages of these two diseases in the vineyards of Kelley's Island, Middle Bass and Sandusky.

North American Fungi. Fourth paper. Lycoperdon. By A. P. Morgan. Jour. Cin. Soc. Nat. Hist., Vol. XIII, 1891, pp. 5-21, pl. 2.

Discusses the species of the genus *Lycoperdon*.

1892.

North American Fungi. Fifth paper. By A. P. Morgan. Jour. Cin. Soc. Nat. Hist., Vol. XIV, 1892, pp. 144-148, pl. 1.

Describes species belonging to genera *Bovistella*, n. gen., *Catasoma*, n. gen., *Bovista* and *Mycenastrum*. Many of the species are from Ohio.

New species of Fungi. By J. B. Ellis and B. M. Everhart. Jour. Mycol., Vol. VII, Mar. 1892, pp. 130-135.

Describe new species, among them being *Tryblidiella pygmæa* from Ohio.

Wild Lettuce—A pestiferous weed. By C. E. Thorne. Bull. No. 44 Ohio Agric. Exp. Sta., Sept. 1892, pp. 141-145, pl. 2.

Describes the appearance of the plant and notes its rapid spread.

Scab of Wheat. By Freda Detmers. Ohio Agric. Exp. Sta., Bull. No. 44, Sept. 1892, pp. 147-149, figs. 2.

Describes appearance and mode of attack of *Fusisporium culmorum* W. Sm., causing scab.

[Fungus on Lactuca]. By Freda Detmers. Ohio Agric. Exp. Sta., Bull, No. 44, Sept. 1892, pp. 145-146, figs. 3.

Gives general account of *Septoria consimilis* attacking cultivated lettuce.

North American Helicosporæ. By A. P. Morgan. Jour. Cin. Soc. Nat. Hist., Vol. XV, Apr. 1892, pp. 39-52, figs. 21.

Describes species of *Helicomycetes*, *Helicoma*, *Helicoön* n. gen., *Everhartia*, and *Troposporium*, many of them occurring in the Miami Valley, Ohio.

1893.

The Myxomycetes of the Miami Valley, Ohio. By A. P. Morgan. Second paper. Jour. Cin. Soc. Nat. Hist., Vol. XVI, [May] 1893, pp. 13-36, pl. 1.

Describes species belonging to genera *Perichæna*, *Ophiotheca*, *Lachnobolus*, *Arcyria*, *Heterotrichia*, *Hemarcyria*, *Calonema* n. gen., *Trichia* and *Oligonema*.

The histology of the stem of *Pontederia cordata*, L. By E. M. Wilcox. Jour. Cin. Soc. Nat. Hist., Vol. XVI, Oct. 1893, pp. 101-104, figs. 4.

Gives some of the features in the histology of the plant mentioned.

1894.

The Myxomycetes of the Miami Valley, Ohio. Third Paper. By A. P. Morgan. Jour. Cin. Soc. Nat. Hist., Vol. XVI, Jan. 1894, pp. 127-156, pl. 2.

Describes species belonging to the genera *Clastoderma*, *Lamproderma*, *Comatricha*, *Stemonitis*, *Enerthenema*, *Diachæa*, *Didymium*, *Spumaria*, *Diderma* and *Lepidoderma*, many of which are found in Ohio.

New Phenogams for the Ohio Flora. By Wm. C. Werner. Jour. Cin. Soc. Nat. Hist., Vol. XVI, Jan. 1894, pp. 170-172.

A list of newly discovered plants of Ohio.

Observations on some Entomophthoræ. By F. M. Webster. Jour. Cin. Soc. Nat. Hist., Vol. XVI, Jan. 1894, pp. 173-177.

Discusses the attacks of parasitic fungi, referred to *Empusa*, on various species of insects occurring in Ohio.

The Russian Thistle in Ohio. By Aug. D. Selby. Bull. No. 55 Ohio Agric. Exp. Sta., Oct. 1894, pp. 53-58, pl. 3.

Describes the plant, its mode of dissemination and gives suggestions for destroying it.

Weeds in General. By Aug. D. Selby. Bull. No. 55 Ohio Agric. Exp. Sta., Oct. 1894, pp. 59-65.

Defines what is meant by a weed and gives text of Ohio weed law.

Black knot—Yellows Law. Bull. No. 55 Ohio Agric. Exp. Sta., Oct., 1895, pp. 66-69.

Text of law requiring destruction of trees affected by Black knot and Yellows.

The next section of the paper under notice is the catalogue of plants proper. This is prefaced by four extra pages, inserted January, 1895, in which are given changes in nomenclature supposed to be necessary by reason of the publication of the new list of plants of northeastern North America, prepared by the committee of the Botanical Club of the American Association for the Advancement of Science. Personally we regret the changes. It seems carrying matters to an extreme. It looks like "splitting hairs," too, when we see so many plants heretofore regarded as varieties being elevated to the rank of species; and sub-genera raised to genera. Be this as it may, however, we must enter a protest against the proposed sweeping changes in our nomenclature. That changes are desirable and probably necessary, no one will deny. But that it is necessary to resurrect obscure, ill defined and long forgotten genera to displace those that have been so long employed in literature, we do not believe. It will probably be denied by many that the changes have been "officially adopted by the American Botanists," and we believe the catalogue would have been improved by omitting these four pages of new names.

One innovation which can not fail to strike every one, is the new arrangement of orders. It has long seemed to us that the old arrange

ment was very defective, and while perhaps some minor changes may be made in the sequence the scheme is, on the whole a good one. Another change is the dropping of capital letters from specific names; and still another the omission of the comma between the species and the authority.

As the authors remark this is the first attempt to catalogue the plants of all orders occurring in the State. Consequently that devoted to the lower orders can not be considered in any sense complete. In examining the various lists we have found some omissions which we supply below.

RANUNCULUS ABORTIVUS MICRANTHUS Gray. Common at Loveland.

RANUNCULUS REPENS L. The most common species in the vicinity of Cincinnati.

NELUMBO LUTEA (Willd.) Pers. Probably extinct about Cincinnati. This fact was noted in Clark's catalogue, 1852, and in that of James, 1879.

OXBAPHUS NYCTAGINEUS Sweet. Escaped from cultivation near Cincinnati.

FUNGI.

MARASMIUS RAMEALIS (Bull.) Fr. Loveland, D. L. James. Herb. U. S. Dept. Agric.

POLYSTICTUS PERENNIS (L) Fr. Herb. U. S. Dept. Agric. D. L. James, Loveland.

PORIA TULIPIFERÆ Schw. Loveland, D. L. James. Herb. U. S. Dept. Agric.

HYDNUM PALLIDUM C. & E. Lancaster, W. A. Kellerman. Herb. U. S. Dept. Agric.

IRPEX PARADOXUS (Schröd.) Fr. Loveland, D. L. James. Herb. U. S. Dept. Agric.

THELEPHORA CARYOPHYLLEA (Schæff.) Pers. Loveland, D. L. James. Herb. U. S. Dept. Agric.

HYMENOCHÆTE IMBRICATA (Schw.) Lév. Cincinnati, A. P. Morgan. Herb. U. S. Dept. Agric.

CORTICIUM LÆVE (Pers.) Fr. Lancaster, W. A. Kellerman. Herb. U. S. Dept. Agric.

TREMELLA FOLIACEA Fr. Lancaster. W. A. Kellerman. Herb. U. S. Dept. Agric.

GEASTER MINIMUS Schw. A. P. Morgan. (N. A. Fungi).

GYMNOSPORANGIUM CLAVIPES C. & P. Wakeman. Herb. U. S. Dept. Agric.

GUIGNARDIA BIDWELLII (Ellis) Viala & Rav. (*Læstadia bidwellii*, Ellis.) The well known and unfortunately too common black rot of grape probably occurs all over the State, certainly about Cincinnati, Cleveland and Sandusky.

HYSTERIUM ROUSSELLII (De Noti) Sacc. Loveland, D. L. James. Herb. U. S. Dept. Agric.

TRYBLIDIELLA PYGMÆA E. & E. (Morgan.)

PLASMIDIOPHORA BRASSICÆ Wor.

ASCOCHYTA CORNICOLA Sacc. (Morgan.)

CYLINDROSPORIUM? OCULATUM E. & E. Put in-Bay, J. J. Davis.

CYLINDROSPORIUM VIRIDIS? E. & E. (Morgan.)

SEPTORIA LEPTOSTACHYA Ellis & Kellerman.

SEPTORIA WILSONI Clinton. Cleveland, B. T. Galloway. Herb. U. S. Dept. Agric.

HELICOMYCES BELLUS Morgan. (N. Am. Helicosporæ.)

HELICOMYCES CINEREUS Peck. (N. Am. Helic.)

HELICOMYCES CLARUS Morgan. (N. Am. Helic.)

HELICOMYCES ELEGANS Morgan. (N. Am. Helic.)

HELICOMYCES FUSCUS B. & C. (N. Am. Helic.)

HELICOMYCES GRACILIS Morgan. (N. Am. Helic.)

HELICOMYCES OLIVACEUS Peck. (N. Am. Helic.)

HELICOMYCES SCANDENS Morgan. (N. Am. Helic.)

HELICOMA AMBIENS Morgan. (N. Am. Helic.)

HELICOMA AMBIGUUM Morgan. (N. Am. Helic.)

HELICOMA BERKLEYI Curt. (N. Am. Helic.)

HELICOMA LARVALE Morgan. (N. Am. Helic.)

HELICOMA LIMPIDUM Morgan. (N. Am. Helic.)

HELICOMA POLYSPORUM Morgan. (N. Am. Helic.)

HELICOMA REPENS Morgan. (N. Am. Helic.)

HELICOÖN SESSILE Morgan. (N. Am. Helic.)

FUSISPORIUM CULMORUM W. Sm. (Detmers.)

MYXOGASTRES.*

- PHYSARUM DIDERMOIDES Rost. (Lister, p. 55.)
 PHYSARUM GLOBULIFERUM Pers. (Lister, p. 40.)
 PHYSARUM INÆQUALE Peck. (Lister, p. 60.)
 PHYSARUM CUCOPUS Link. (Lister, p. 39.)
 PHYSARUM MELLUM Mass. (Lister, p. 43.)
 PHYSARUM MULTIPLEX Peck. (Bull. Torr. Bot. Club. Vol. XI.
 1884.)
 PHYSARUM MURINUM Lister. (Lister, p. 41.)
 PHYSARUM PULCHERRIMUM Berk & Rav. (Lister, p. 42.)
 PHYSARUM PULCHRIPEs Peck. (Lister, p. 40.)
 PHYSARUM TENERUM Rex. (Lister, p. 44.)
 FULIGO ELLIPSOSPORA Lister. (Lister, p. 67.)
 CRATERIUM MUTABILE Fr. (Lister, p. 73.)
 CHONDRIODERMA FLORIFORME Rostf. (Lister, p. 85.)
 LAMPRODERMA ARCYRIONEMA Rostf. (Lister, p. 127. Morgan,
 LAMPRODERMA ARCYRIOIDES Somm. (Morgan, Myx.)
 LAMPRODERMA IRIDEUM Mass. (Lister, p. 128. Same as *L. scin-*
tellans B. & Br. of Morgan, Myx.)
 COMATRICA AEQUALIS Peck. (Myx.)
 COMATRICA CRYPTA Schw. (Myx.)
 COMATRICA FLACCIDA Lister. (Myx.)
 COMATRICA LONGA Peck. (Lister, p. 119. Myx.)
 CLASTODERMA DEBARYANUM Blytt (Lister, p. 132. Myx.)
 STEMONITES MICROSPORA Lister. (Myx.)
 ENERTHENEMA PAPILLATUM Pers. (Myx.)
 DIACHÆA SPLENDENS Peck. (Myx.)
 DIDYMIUM ANELLUS Morg. (Myx.)
 DIDYMIUM CLAVUS A. & S. (Myx.)
 DIDYMIUM EXIMIUM Peck. (Myx.)
 DIDYMIUM MICROCARPUM Fr. (Myx.)
 DIDYMIUM MINUS Lister. (Myx.)

Myx.)

*The law of priority needs no straining to adopt this name instead of the more commonly used *Myxomycetes*. It was proposed by Fries, in 1829, four years previous to the use of *Myxomycetes* by Wallroth (1833). The additions to the catalogue here given are taken from Morgan's Papers and from Lister's "Mycetoza," published in 1894. This latter author makes many changes in nomenclature and reduces many species to the rank of synonyms. Whenever in his list of localities Ohio is mentioned, it is included in these additions.

DIDYMIUM PROXIMUM B. & C. (Myx.)
SPUMARIA ALBA DC. (Lister, p 104.)
SPUMARIA ALBA MUCILAGO Nees. (Myx.)
DIDERMA CINEREUM Morg. (Myx.)
DIDERMA CRUSTACEUM Peck. (Myx.)
DIDERMA DIFFORME Peck. (Myx.)
DIDERMA EFFUSUM Schw. (Myx.)
DIDERMA FLORIFORME Bull. (Myx.)
DIDERMA GLOBOSUM Pers. (Myx.)
DIDERMA MICHELII Lib. (Myx.)
DIDERMA RADIATUM L. (Myx.)
DIDERMA RETICULATUM Rost. (Myx.)
DIDERMA SPUMARIOIDES Fr. (Myx.)
DIDERMA STROMATEUM Link. (Myx.)
DIDERMA TESTACEUM Schr. (Myx.)
LEPIDODERMA TIGRINUM Schr. (Myx.)
CRIBRARIA LANGUESCENS Rex (Lister, p. 145.)
ENTERIDIUM ROZEANUM Wing (Lister, p. 159.)
PERICHÆNA POPULINA Fr. (Lister, p. 198.)

The authorities given for the species taken from Lister's Mycetozoa will probably be found to disagree in many cases with those given by other writers. In his citations he gives as the author of the name the one who first used the special combination adopted. Take for example *Enteridium rozeanum* Wing. The specific name was first used by Rostafinski in 1876, while the combination quoted above was used in 1880 by Wingate. The proper and now generally accepted method of citing authorities would then in this case be *Enteridium rozeanum* (Rost.) Wing.

Washington, D. C., May 13, 1895.

MINERAL SYNTHESIS.

BY G. PERRY GRIMSLEY, PH. D.

(Continued from Vol. XVI, p. 169.)

III.

EXPERIMENTS AND RESULTS.

The history and methods of mineral synthesis have been outlined in a former paper. It is proposed in the present article to give an account of a number of important experiments and the results of the work.

The crystals formed by artificial synthesis are neither large in size nor of great beauty. The process of sublimation furnishes the largest specimens but nearly all these crystals must be studied under the microscope. The size, beauty and perfection of the crystals depend on the methods and apparatus used in their formation. In many cases these properties seem to be intimately connected with the nature of the bodies. Thus it is more difficult to obtain good crystals of leucite than of nepheline. Magnesian mica (biotite) crystallizes more easily than the lithium mica (zinnwaldite). It is more difficult to obtain the alumina and sodium pyroxenes in crystalline aggregates than the magnesia and iron varieties. Among feldspars *anorthite* is most easily formed; among the zeolites, *analcite*; among potassium and magnesian silicates, *olivine*; among sodium and aluminum silicates, *nepheline*.

Very interesting and instructive for study are the growth forms shown when the reaction is slow in crystallizing from fusion or chemical precipitation. These rudimentary forms may be observed, perhaps best, in the minerals leucite and nepheline.

A careful comparison of the methods and results of synthesis shows a marked influence of the manner of formation on the crystal habit or form in very many crystals. Sodium chloride (common salt) generally occurs in cubes, yet from a caustic soda or ammonia solution octahedra are formed. When augite is crystallized rapidly from fusion long lath crystals are formed with characteristic augitic combination of planes; but if the augite is formed by slow crystallization, the forms are short thick prisms or grains. One of the best illustrations

of this influence of method on crystal form is shown in rutile. (See figure I.) When this mineral is crystallized from a hydrochloric acid solution fine needles are formed. If produced by the decomposition of a titanate through quartz, octagonal prisms result; while a fusion of amorphous titanous acid in the presence of a fluorsilicate of potash produces tabular crystals.

In a number of other cases different methods of formation produce the same forms, so pyrite always is formed in cubes.

It is now proposed to describe some of the experiments in the reproduction of a number of the more important minerals. The most widely distributed type, which is to be found in nearly every locality is *quartz*. Very few of its many varieties have as yet been formed in the laboratories. The elongated prismatic type terminated by the double pyramid and tridymite alone have been formed. The prismatic variety was first formed in 1845, by Schafhautl, who heated in a Papin furnace for ten days, gelatinous silica recently precipitated. The silica was dissolved and the solution evaporated, and on examining the white powder under the microscope small hexagonal bipyramidal quartz crystals were seen.

Daubree noted that the same product resulted from the attack of heated water on glass in a closed vessel. When this action was continued for many weeks at a temperature of 320 degrees, the glass was transformed into a mass of kaolin leaves, and on the surface of each a lens disclosed the prisms and pyramids of quartz. These minute crystals belonged to the two types of right and left handed forms, and they showed striations on the prism faces just as on natural crystals. Small chalcedony spherulites were also formed.

Another very important group of minerals in the formation of crystalline rocks is the *feldspar* family. On account of this importance numerous attempts were made to reproduce them but for a long time without success. Leonhard, in 1858, says of these attempts: "The chemists have not succeeded in reproducing feldspar. Mitscherlich attempted to obtain it by the fusion of its elements and always obtained a vitreous mass with no trace of crystalline structure, and so concludes that minerals containing potash and aluminum cannot be reproduced in crystalline form. Before fusion they pass from the solid state to the viscous."

In 1810, the accidental formation of orthoclase was noted in a

number of furnaces. The only triclinic feldspar noted as accidentally formed is *anorthite* recorded by Velain in 1878.

Nineteen years after Leondard wrote the statement above, the first successful attempt at the reproduction of feldspar was made, when Hautefeuille formed *orthoclase*. He heated at a temperature of 900 degrees, a mixture of tungstic acid and a very alkaline silico-aluminate of potash. The resulting products were orthoclase, triclinic silico-aluminate of potash, and tridymite. By changing the proportions the two side products disappeared after twenty days heating. The orthoclase crystals possessed the physical and optical properties of the natural mineral.

By an analogous method with the silico-aluminate of soda, this investigator formed *albite*.

By a fusion of the elements, Foque and Levy formed *anorthite*. (See figure 1,) *oligoclase* and *labradorite*. The crystals were usually microlites one millimetre long and twinned after the albite law. All the feldspars were reproduced by igneous agency, but the more basic ones are the more readily formed. The synthetic work on feldspars has confirmed the theory of Tschermak that the various tri-clinic feldspars are not distinct species, but they are isomorphous mixtures of an albite (sodium) molecule and an anorthite (calcium) molecule.

By a fusion of silica, alumina, carbonate of soda, with strontium, barytes, and oxide of lead, Foque and Levy obtained new feldspars with those bases. After their experiments were published, Des Cloizeaux discovered a natural barytes feldspar (*hyalophane*) with properties like the artificial one, but so far no lead or strontium feldspar has been noted in nature.

The two most important minerals in the alkaline series of rocks are *leucite* and *nepheline*. (See figure 1.) The former was reproduced in 1880, by Hautefeuille, by a fusion of a mixture of silica, aluminate and vanadate of potash at 800 degrees temperature during twenty-five days. The same action on the aluminate of soda with an excess of vanadate of soda gave crystals of *nepheline*.

In the sedimentary rocks the more important minerals are *calcite* and *dolomite*. Calcite was first formed by James Hall, in 1801. This experiment was repeated by Bischof and also by Rose, in 1837. The latter proved that the same action produced crystals of calcite and aragonite (orthorhombic form) which were formed at different parts of

the vessel according to the diverse conditions of temperature. When the solution was evaporated at ordinary temperature, the walls of the vessel and the surface of the liquid were covered with a crust of calcite crystals, while the bottom was coated with a granular layer of calcite. If the solution be evaporated at a low temperature in a vessel largely covered; the surface of the liquid is covered with crystals of aragonite while the bottom is coated with calcite rhombohedra.

Dolomite was formed by Morlot, in 1847, by heating a solution of sulphate of magnesia in a closed tube at 200 degrees. Durocher heated to redness in a sealed gun-barrel fragments of porous limestone and magnesium chloride. This temperature was kept for three hours, when the pieces of limestone were covered with a scoriaceous coat which was treated with boiling water. The microscope disclosed an aggregation of grains of crystalline dolomite. From this experiment Durocher concluded that dolomite was formed in nature by the action of a solution of magnesium salt on calcium carbonate under slightly increased temperature and pressure.

Most of the minerals employed in the arts and industries have been reproduced. *Galena* was often noted as an accidental product and nearly always with cubic form. Senarmont, in 1851, formed galena crystals by a method which now is commonly used in the formation of most metallic sulphides. He placed in a glass tube with thick walls the

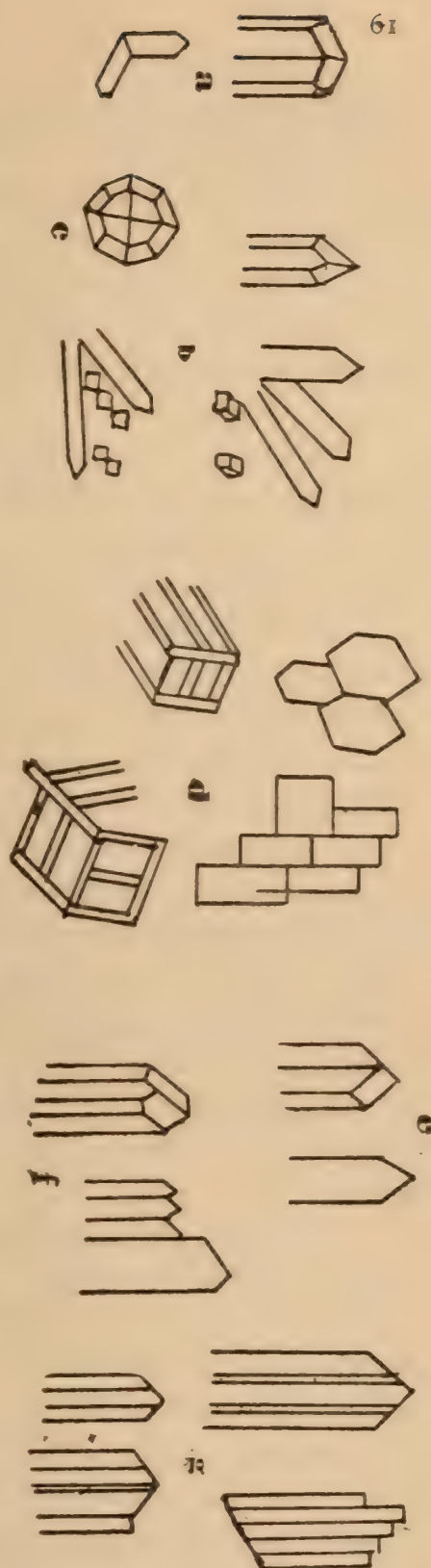


FIGURE I.
ARTIFICIAL MINERALS,
(After Doelter.)

- | | |
|--------------|--------------|
| a—Rutile. | e—Olivine. |
| b—Argentite. | f—Augite. |
| c—Leucite. | g—Anorthite. |
| d—Nepheline. | |

amorphous sulphide of lead and a solution of hydrogen sulphide under strong pressure. This mixture was heated to 150 degrees and then as the temperature was reduced, the lead crystallized in small brilliant cubes.

Fluorite was formed by Senarmont, in 1850, by heating the gelatinous fluorite precipitate in the presence of bicarbonate of soda in a sealed tube at 180 degrees. The crystals were in the form of cubic octahedra.

Cassiterite was obtained in brilliant crystals of a brown color by Daubree, in 1849. He heated to redness in a porcelain tube, water vapor and bichloride of tin vapor. When lime was used instead of water, the result was produced as before.

Silver crystals were obtained by Margottet, in 1877, by the reduction of silver sulphide at a temperature of 440 degrees. *Gold* was formed in crystals of some size, in 1863, by Knoeffl, who heated for ten days at a temperature of 80 degrees, an amalgam of gold and mercury treated with nitric acid.

The original workers in mineral synthesis concentrated their crude efforts on the formation of gem stones seeking to enrich themselves rather than science. Failing in this they could see no further value in the experimental formation of minerals. Though the primary object of these attempts has never been attained, they have contributed interesting and instructive data concerning the origin of the precious minerals. The small and imperfect crystals are commercially without value, while scientifically they are of the greatest value.

Corundum, for example, has been formed in a large number of ways. Gaudin, in 1837, first obtained this substance in definite crystals. His method consisted in heating at a high temperature, potash alum, with or without the addition of potassium sulphate, and on cooling clear crystals of corundum separated out. A more remarkable method was employed by Senarmont, in 1850, who heated in a closed tube at 350 degrees a mixture of chloride of alumina, azotate of alumina, and water, whereby small rhombohedra were obtained. Ebelmen introduced small quantities of the oxides and obtained the various colors, ruby, sapphire, etc.

Diamonds as yet have probably not been reproduced. The early attempts to form them by the fusion of graphite in electric currents were clearly at fault, for Brewster and Göppert discovered in the

diamond, liquid inclusions which would be altered by high temperatures, thus showing that diamonds in nature were formed at temperatures but little different from the ordinary. The artificial reproduction is reported as realized by Kannay, but as the secret is carefully guarded, the success is not known.

Emeralds were produced in 1848, by Ebelmen, by heating at high temperature a mixture in varying proportions of boric acid and pulverized natural emerald with a small addition of oxide of chrome. The resulting crystals were small hexagonal forms with a green color.

Melanite garnet (calcium) was formed in 1808, by Klapproth, by the fusion of the mineral idocrase. Von Kobell, in 1827, fused the natural melanite garnet and allowed it to cool gradually when it assumed the octahedral form which is rarely seen in nature.

A survey of the whole work of mineral synthesis shows that previous to 1849, twenty-three minerals had been formed in the laboratory, while since that year over one hundred others have been reproduced. The year 1850 marks the real beginning of this important work. The number of minerals not artificially formed is quite small. Foque and Levy in their work on this subject published in 1882, noted thirty minerals as not reproduced and described the formation of one hundred and thirty species thus leaving a number of less important minerals without mention.

Zirkel, in his new petrography published near the end of 1893, gives a list of seven minerals not yet reproduced. These are *epidote*, *allanite*, *zoisite*, *staurolite*, *disthene*, *andalusite*, and *tourmaline*. It is interesting to note that with one exception (allanite) these are metamorphic minerals, showing that the exact conditions of metamorphic action have not yet been realized in the laboratory.

IV. ROCK SYNTHESIS.*

When the artificial reproduction of the important minerals was accomplished, the attempt was made to unite these into rocks like those occurring in nature. Foque and Michel Levy were the pioneers in the work, commencing their work in 1877 and achieving great success in a short time. In the following five years they reproduced nearly all the basic rocks and made important discoveries concerning the origin of the acid series.

* See plate IV, taken from Foque and Levy's work, which represents thin sections of artificial leucite tephrite and artificial basalt magnified.

Andesites were obtained in well crystallized specimens with the normal structure, by fusing a mixture of four parts oligoclase and one part augite. The mass was heated at a moderate temperature for three days. The resulting microlites of oligoclase feldspar averaged one-fourth millimetre long and 0.015 mm. broad. The augite was of pale yellow color and in much smaller crystals than the oligoclase. They were distributed irregularly among the feldspar microlites. Octahedra of magnetite also were formed from the iron of the augite employed. By the introduction of a slight excess of lime, microlites of labradorite feldspar were formed. Augitic andesite was also formed from a mixture of ten parts of oligoclase to one part of hornblende. In this operation the hornblende is transformed into pyroxene.

Basalts (see plate IV) were produced by heating a black homogeneous glass of the composition of an olivine rich basalt (6 parts olivine, 2 parts of augite, 6 parts of labradorite.) The mixture was kept at red heat for ninety-six hours. The resulting product, weighing fourteen grams, contained the minerals, olivine, picotite, labradorite, augite, magnetite, and it was identical in every way with certain natural basalts especially those of the Auvergne (France). This artificial rock does not contain water, but microscopical examination of natural basalts shows that the water is due to secondary alteration, especially of olivine. These experiments definitely settle the question of origin of basalts and show that they are of purely igneous origin.

Nephelinites. A mixture of three parts nepheline to one and three-tenths of augite fused and heated for two days yielded a crystalline product composed of microlites of nepheline and augite. When the amount of augite is reduced, this mineral no longer appears in the new rock. Thus ten parts of nepheline to one part of augite gives an association of beautiful nepheline crystals, small octahedra of spinel, and brown isotropic dodecahedra of melanite garnet.

Leucite-tephrites. The chemical elements of the minerals composing this rock (leucite, labradorite, augite) are fused to a homogeneous glass which is then heated for forty-eight hours at a white heat, when the leucite elements are isolated and pass into a crystalline state. A second heating is made for the same length of time at a cherry red heat, below the fusing point of the feldspar, when the whole mass becomes crystalline.

Foque and Levy heated a mixture of silica, alumina, potash, soda, magnesia, lime, iron oxide, representing one part of augite,

four parts of labradorite, and eight parts of leucite. The resulting crystalline product showed in thin sections under the microscope, augite, labradorite, and leucite, in the usual proportion. (See plate IV.)

Lherzolite. The crystallization of the constituents of this rock, olivine, enstatite, augite, picotite, was easily made. The resulting product differed from the natural rock in a difference in the form of picotite, and in having a greater number of vitreous inclusions.

Meteorites without feldspar. A mixture of twelve grams of silica, three of magnesia, and five and one-half grams of sesquioxide of iron fused at high temperature and quickly cooled, formed a crystalline mass very like the natural meteorites.

Meteorites with Feldspar. These types were called eukrites by Rose. They are artificially formed by a fusion, during ninety-six hours, of a mixture of silica, alumina, magnesia, calcium carbonate, and iron sesquioxide. The resulting product in thin sections shows, enstatite, anorthite, olivine, magnetite, and a characteristic ophitic structure.

Foque and Levy vainly attempted to form by ingeous fusion those rocks which contained quartz, orthoclase, albite, muscovite, biotite, and hornblende. *Quartz* on fusing lost its power to act on polarized light. The optical properties of *orthoclase* were changed while *albite* fused to a glass. *Biotite* changed to a mass of pleochroic orthorhombic crystals. *Microcline* fused with muscovite gave an isotropic glass. Four parts of microcline fused with nearly five parts of biotite gave a crystalline mass composed of leucite, olivine, magnetite, melilite, which is a variety of *olivine leucite*.

These negative experiments show that the natural rocks, with quartz, orthoclase, biotite, hornblende, are formed by another method than that of pure igneous fusion.

RESUME. Both the chemical composition and the conditions of cooling influence rock structure. An absence of lime and alkali gives to lherzolite a granitoid structure. The trachytoid and especially the microlitic structures are very characteristic of the purely igneous rocks.

To the list of purely igneous rocks there must be added those which show relations to them, though they cannot be reproduced by the same methods. These are the acid rocks, *hornblende andesites*, *trachytes*, *phonolites*, which have not been artificially formed by igneous fusion. These types pass gradually into the more and more acid

rocks terminating in granite whose real method of origin is as yet not definitely settled.

Foque and Levy conclude that if the origin of granite was known the classification of rocks could be established on a natural basis, since the mode of formation and bulk composition would be known, together with the mineralogical association and structure.

In the meantime such a classification must be based on those points which we are able to discover.

LITERATURE.

A list of the leading works on this interesting subject is here appended. Those who may wish to pursue the discussion further will find complete literature references given in the books. While these two papers are based on the descriptions given in the different books cited below, especial use was made of the work of Foque and Levy which gives a concise treatment of the whole subject:

Fuchs—*Die Künstlichen Mineralien*, 1870.

Daubree—*Etudes synthetiques de geologie experimentale*, Paris, 1879.

Foque et M. Levy—*Synthese des mineraux et des roches*, Paris, 1882.

Bourgeois—*Reproduction artificielle des mineraux*, Paris, 1884.

Dœlter—*Chemische Mineralogie*, pp. 107-172, Leipzig, 1890.

Meunier—*Les Methodes des syntheses mineraux*, 1892.

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MANUAL OF THE PALEONTOLOGY OF THE CINCINNATI GROUP.

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PART VI.

(Continued from Vol. xvi, p. 208.)

GROUP IV. *Laminar or Frondescant*: Expanded or flattened, sometimes formed of two layers of corallites diverging from a central axis; sometimes more or less irregular.

- a.* Surface with conspicuous monticules.
 - * Interstitial cells absent; monticules with larger calices than average 41
 - * Interstitial cells few.
 - † Monticules with calices of average size 42, 43
 - † Monticules with cells larger or smaller than average. 44
- b.* Surface with small monticules or stellate maculæ.
 - * Interstitial cells absent 45
 - * Interstitial cells few.
 - † Stellate maculæ with angular cells 46
 - † Monticules with cells smaller than average 47
 - † Monticules with cells larger than average 48
 - * Interstitial cells numerous.
 - † Maculæ with cells smaller than average 49
 - † Monticules with cells of average size 50, 51
 - † Maculæ with cells larger than average 52, 53, 54
- c.* Surface smooth.
 - * Interstitial cells absent 55
 - * Interstitial cells few 56, 57
 - * Interstitial cells numerous 58, 59, 60

NOTE.—Keys of this kind are necessarily more or less defective and artificial, but they are believed to be of use to the student in tracing out some form which he may have found. It should, of course, be understood that only the salient characters of each are given, and for the more detailed description attention must be given to the text.

41.—*M. CLEAVELANDI* James, 1882.

Corallum lobate or amorphous, with flattened or cylindrical branches; surface with rounded monticules, more or less conspicuous, about one line apart, occupied by calices larger than in other places; calices polygonal or sub-circular; no interstitial pores at the surface; walls of corallites in the axial region very thin and tortuous, the tubes inclining gently outward and opening in a slightly oblique direction; tabulæ complete and numerous, more closely set near the surface than in the axial region, direct, curved or oblique; corallites polygonal; spiniform corallites somewhat angular. (The Paleontol., No. 6, Sept. 1882, p. 47.)

Locality.—Highland county, O.

42.—*M. DAWSONI* Nicholson, 1881.

Corallum irregularly lobate or frondose, forming an undulated expansion of variable size, about two lines thick; surface with numerous close-set, prominent monticules, markedly elongated, about a line or less apart, and occupied by corallites not differing conspicuously in size from those forming the mass of the corallum; calices polygonal, thin walled, nearly vertical from a central axis, and opening on either side: no regular series of small apertures, but occasionally a few spiniform corallites at angles of junction of cells; walls delicate, wrinkled, slightly thickened toward mouths of cells; corallites vertical and bending outward to the surface with a very gradual inclination; in the axial region with thin, wavy or undulated walls, which become thickened in the cortical region; tabulæ wanting in the axial but moderately developed in the cortical region, complete and horizontal and about the same in number in both large and small corallites: tangential sections show only one series of corallites, approximately of the same size, polygonal; occasional interstitial corallites, but numerous minute, circular, thick-walled spiniform corallites. (Genus Montic., 1881, p. 141.)

Locality.—Warren and Clinton counties, Ohio. Rare at Cincinnati.

Remarks.—This is similar to *M. mammulata*, but differs in the more prominent, elongated and closely set monticules.

43.—*M. MOLESTA* Nicholson, 1881.

Corallum usually frondescant, forming extended and undulated, lobed or palmate expansions, varying in thickness from two to five

lines; rarely massive; surface with numerous prominent conical or elongated monticules, one-half to one line apart, of corallites not differing in size from the average; calices polygonal, thick-walled, sub-equal with a few interstitial corallites; corallites of two kinds, the larger more numerous, thin-walled and polygonal, mostly with tabulæ forming a series of lenticular vesicles along one side of the visceral chamber and a moderate number of straight or slightly concave tabulæ extending to the opposite wall: smaller corallites comparatively few, angular, varying in size, and with numerous, complete, horizontal tabulæ; no spiniform tubuli. (Genus Montic., 1881, p. 224.)

Locality.—Cincinnati, Ohio, and Covington, Ky., etc.

Remarks.—It is to be noted that this species is similar to the one following in its outward appearance. It furnishes an example of the difficulty of accurately settling the specific name of a species without the examination of minute sections. In a previous paper, * indeed, both were placed together, but it is now deemed best because of the difference in internal structure to separate them. The presence of vesicular tabulæ in this form distinguishes it from the other (*mammulata* as here considered) which has horizontal and complete tabulæ.

44.—M. MAMMULATA D'Orb., 1850.

Corallum in undulated expansions, two to six lines or more thick, often consisting of several layers of corallites, diverging from an imaginary, but not a definite plane and opening on both sides; occasionally massive; surface with rounded, conical or elongated monticules, either conspicuous or only slightly raised; these occupied by corallites either slightly larger or slightly smaller than the average; or else the sides with full-sized, and the summit with smaller corallites; calices of two kinds: large ones polygonal, or sub-polygonal with moderately thickened walls at the surface; small ones moderately numerous, intercalated between the larger tubes, variable in size and shape, but always angular or sub-angular; spiniform corallites variable in number; tabulæ of large corallites few and remote; of small corallites numerous and closely set, in both cases all complete and approximately horizontal. (Prodr. de Pal., vol. 1, 1850, p. 25; Nicholson, Genus Montic., 1881, p. 104.)

Locality.—Cincinnati and vicinity: generally distributed throughout the group.

* Jour. Cin. Soc. Nat. Hist. vol. 11, 1888, p. 16.

Remarks.—This species is generally regarded as the type of the whole genus *Monticulipora* inasmuch as it was the first species described by D'Orbigny. There has been considerable discussion as to what was intended by D'Orbigny because there are several species similar externally but differing in other ways. Dr. Nicholson admits that D'Orbigny might have had in mind either this species, his *M. molesta*, or *M. dawsoni*. The selection is, therefore, somewhat arbitrary. Mr. Ulrich contends that Nicholson is mistaken in his form and that *M. molesta* is really *M. mammulata* D'Orb., while *M. mammulata* of Nicholson is something else. We have followed Dr. Nicholson in selecting the form known as *mammulata*. It is one of the commonest species of the genus at many exposures of the group in Ohio and Indiana. In the collection of the late Mr. U. P. James is a massive specimen about nine inches in its longer and five inches in its shorter diameter. About half of the longer diameter forms a dome-shaped mass, the surface irregular and covered with small, closely set monticules. Inside are several branches extending downward and spreading out into a wonderfully interlaced mass of frondescent branches. These branches are surrounded by a mass of clay.

45.—*M. PAVONIA* D'Orb. (sp.), 1850.

Corallum forming a thin, undulating expansion, often of considerable extent, varying in thickness from one to about two lines, the corallites in two layers with their bases fixed to a medium plane marked by a delicate membrane and opening on opposite sides of the corallum; surface with low, rounded monticules, often obscure, and arranged in diagonal rows at intervals of from one to one and a half lines apart, occupied by calices of ordinary size; corallites generally oblique at their origin, but almost immediately bending outwards, and opening at right angles to the surface or nearly so; calices elongated, pentagonal, tolerably uniform in size and often arranged in obliquely intersecting lines; no interstitial cells; walls of corallites at first thin, but rapidly becoming thickened; a few complete and horizontal tabulæ in some but not all of the corallites, and these often placed at corresponding levels in contiguous tubes. (Prodr. de Paleont., vol. 1, 1850, p. 22, as *Ptilodictya pavonia*.) (*Cyclopora jamesi* Prout, Trans. St. Louis Acad. Nat. Sci., vol. 1, 1860, p. 578; *Chætetes clathratulus* (James) Nicholson, Quart. Jour. Geol. Soc. London, vol. 30, 1874, p. 259.)

Locality.—Cincinnati, Ohio.

Remarks.—This species is readily recognized by its thin, undulating corallum, which carries the sub-oval, oval or pentagonal calices on both sides arranged in decussating lines. Some specimens have been found nine inches by four inches, with evidence that they were even larger. Sometimes low monticules are thickly distributed over the surface; some specimens show a pointed base but none show the non-poriferous margin characteristic of *Ptilodictya*, to which the species has been referred. Considerable difference of opinion has existed in regard to the zoological position of the species, some calling it a coral and some a polyzoan. It is possible that it may really be one of the latter group.

46.—*M. CURVATA* Ulrich (sp.), 1882.

Corallum ramose or frondose, branches flattened; surface with small, stellate maculæ, composed of shallow angular cells; ordinary corallites rounded or angular, with moderately thick walls, varying in diameter from $\frac{1}{140}$ to $\frac{1}{130}$ inch; corallites polygonal in the outer part of the corallum with thickened walls, apparently completely amalgamated; spiniform tubuli numerous, of moderate size; corallites in the axial region with thin, flexuous walls, crossed by tabulæ one or two tube diameters apart; more numerous in the peripheral region; vesicular diaphragms crowded and developed in nearly all the tubes. (Jour. Cin. Soc. Nat. Hist., vol. 5, p. 242, as *Homotrypa curvata*.)

Locality —Cincinnati, Ohio.

Remarks.—This species was in a former article * placed as a synonym under *M. frondosa*. At present and pending a complete examination of all the described species it is restored to specific rank.

47.—*M. VAUPELI* Ulrich (sp.), 1883.

Corallum irregularly twisted, formed of more or less inosculating masses; several inches in diameter, and consisting of convoluted fronds, varying from one and one-half to three lines thick; surface sometimes smooth, but usually with irregularly arranged small, rounded or conical monticules; the summit of these sub-solid, and each occupied by maculæ of small cells; calices circular, arranged in decussating lines, more or less curved around the monticules; generally one or two rows of cells larger than the average surrounding the

* Jour. Cin. Soc. Nat. Hist. vol. 11, p. 17.

maculae; interstitial spaces sometimes smooth and apparently solid (in worn specimens); sometimes with small interstitial cells, and again (in the best preserved specimens), with numbers of spines or granules on the walls of the interstitial cells; corallites in the axial region with moderately thin and flexuous walls, thickening toward the surface; sub-angular or nearly circular and in contact at limited points, the intervening spaces occupied by smaller and angular interstitial cells; spiniform tubuli, if any, small and inconspicuous; in the mature region interstitial cells seemingly suppressed by the spiniform tubuli, which are arranged in one or two crowded series; tabulae usually wanting in the large corallites in the axial region and not numerous elsewhere; in the interstitial cells numerous and closely set. (Jour. Cin. Soc. Nat. Hist. vol. 6, 1883, p. 85, as *Heterotrypa vaupeli*. Placed in the new genus *Nicholsonella* in Geol. Sur. Ills., vol. 8, 1890, p. 421.)

Locality.—Cincinnati and Waynesville, Ohio.

48.—*M. PUSTULOSA* Ulrich (sp.), 1890.

Corallum sub-ramose or irregularly compressed, averaging eight mm. thick; surface generally with low monticules, about 2.6 mm. apart, consisting of groups of larger cells with a few small ones; corallites slightly flexuous, somewhat thickened in the cortical region, polygonal, hexagonal and pentagonal, nine in two mm.; calices sub-polygonal, one-half larger in the monticules than elsewhere; in the axial region tabulae twice their diameter apart, becoming more numerous toward the periphery; spiniform corallites fairly numerous, commonly situated at the angles. (Geol. Sur. Ills., vol. 8, 1890, p. 451, as *Amplexopora pustulosa*.)

Locality.—Hanover, Clarksville, and other places in Ohio.

49.—*M. FRONDOSA* D'Orb., 1850.

Corallum of erect, flattened, undulating expansions of variable height, and varying from less than one to four lines thick; surface with numerous rounded or stellate spaces, either elevated to form monticules, or level with the general surface, and composed mainly of small tubuli; larger calices moderately thick walled, irregularly circular, oval or sub-polygonal; these surrounded by a variable, generally large number of smaller, irregularly shaped calices, occupying the intervals between the preceding, and sometimes almost surrounding

them; spiniform corallites numerous, placed on margins of calices or forming apparently closed tubercles; corallites springing from both sides of median axis, forming two laminæ, sometimes marked by a calcareous membrane; oblique and thin walled at first, but soon bending outward and proceeding straight to the surface, the walls there moderately thickened; larger tubes with incomplete tabulæ, forming a series of vesicles on the side of the visceral chamber, which may and may not be connected with the opposite side by horizontal tabulæ; interstitial corallites with numerous, closely set, horizontal and complete tabulæ. (Prodr. de Paleont., vol. 1, 1850, p. 25; Nicholson, Genus Montic., 1881, p. 216.) (*Chaetetes decipiens* Rominger, Proc. Acad. Nat. Sci. Phila., 1866, p. 116.)

Locality.—Cincinnati, Ohio.

Remarks.—This species grows in much the same manner as *M. molesta*, *dawsoni* and *mammulata*. It may be distinguished from them, however, by its smoother surface and by the presence of a well defined lamina or plate separating the bases of the corallites which open on opposite sides of the corallum. Specimens can sometimes be separated along this lamina.

50.—*M. CLINTONENSIS* James, 1882.

Corallum variable, flattened, undulating, thickened or contorted, amorphous and occasionally appearing as if branched; surface with rounded, more or less prominent monticules of average size, or at times nearly smooth; calices of various forms, the walls indented or irregularly expanded; corallites more or less twisted and tortuous in the axial region, then curving abruptly to the surface, in the sub-cylindrical branches appearing to curve and then radiate in every direction to the surface; about eight calices in one line; corallites with thin walls and remote tabulæ in the central portion, becoming thicker walled and with more numerous tabulæ toward the surface; interstitial corallites more or less numerous at the angles of the larger tubes, with a variable number of tabulæ; spiniform corallites few to numerous; in tangential section the corallites have thick walls and are irregular, being indented and expanded, appearing three or four lobed; below the tangential section the corallites are more regular in shape, and lower still are oval or circular. (The Paleontologist, No. 6, Sept., 1882, p. 45.)

Locality.—Clinton and Warren counties, Ohio.

Remarks.—The indented walls of the calices and the peculiar mode of growth will generally distinguish this species. In the last respect it resembles *M. varians* and *M. vaupeli*, but in other respects it is different.

51.—*M. CUMULATA* Ulrich (sp.), 1890.

Corallum irregular, sometimes sub-massive and again sub-ramose, consisting of one or more superimposed layers from 0.7 to four mm. thick, the inner side generally with an epitheca or loosely attached to some foreign body; surface sometimes smooth, but generally with low, rounded, rather irregularly arranged monticules, two mm. or more apart, with the calices scarcely larger than in the intermediate spaces, but separated by greater intervals; corallites slightly curved near their origin in each layer and then proceeding direct to the surface; crossed by horizontal tabulæ one or two times their diameter apart; calices sub-circular with a faintly elevated and minutely spinulose margin when perfect; seven in two mm.; interspaces usually narrow, with small, closely tabulated, angular, interstitial corallites, which just below the aperture are filled with a dense deposit of material. (Geol. Sur. of Illinois, vol. 8, 1890, p. 423, as *Nicholsonella cumulata*.)

Locality.—Wilmington, Ills.

52.—*M. CONTEXTA* Ulrich (sp.), 1890.

Corallum frondescant, formed of a mass of irregular, coalescing branches varying from three to six mm. thick; surface smooth, with spaces having larger cells than the average; walls of corallites scarcely thicker in the cortical than in the axial region; calices sub-circular or oval, eight to ten in two mm., occasionally in contact but ordinarily separated by the angular, thin-walled interstitial tubes which are very numerous and nearly the same size as the ordinary cells; tabulæ few in the axial region, becoming more numerous toward the surface, where they are abundant and extend from the vesicular tabulæ to the opposite wall; closely set tabulæ in the interstitial cells, approximately upon the same level in all; spiniform corallites small, but conspicuous in the tangential section, three to five around each corallite. (Geol. Sur. of Ills., vol. 8, 1890, p. 412, as *Homotrypella contexta*.)

Locality.—Wilmington, Ills.

53.—M. PROLIFICA Ulrich (sp.), 1890.

Corallum frondescient or sub-ramose, with flattened branches varying from four to twelve mm. thick; surface with low rounded monticules arranged in irregularly intersecting lines, composed of cells a little larger than the average, commonly surrounding a cluster of interstitial cells; corallites curved in the axial but direct in the peripheral region, where walls are thickened; calices sub-polygonal, eight in two mm., the interspaces occasionally with a few interstitial cells, although these are mostly in the clusters; tabulæ in the axial region few, but closely set and more or less funnel-shaped in the cortical region; interstitial cells more closely tabulate than the ordinary corallites; spiniform corallites about one-third more numerous than the ordinary corallites, and when not at the angles causing an inflection of the wall. (Geol. Sur, Ills., vol. 8, 1890, p. 413 as *Heterotrypa prolifica*. Pal. of Minn., vol. 3, Geol. and Nat. Hist. Sur. Minn., 1893, p. 268.)

Locality.—Blanchester, O., Wilmington, Ills.

54.—M. FLABELLARIS Ulrich (sp.), 1890.

Corallum frondescient, fan-shaped; surface smooth with obscure maculæ about four mm. apart and with calices from one-third to one-half larger than the average; walls of corallites flexuous or crenulated in the axial region and very thin in the cortical region; calices angular, slightly oblique eight to ten in two mm.; interstitial cells few, gathered into clusters in the maculæ; tabulæ straight and few in the axial region, moderately numerous in the smaller cells; vesicular diaphragms forming a short series in each tube; spiniform corallites few and very small. (Geol. Sur. Illinois, vol. 8, 1890, p. 411, as *Homotrypa flabellaris*.)

Locality.—Wilmington, Illinois.

55.—M. COMPRESSA Ulrich (sp.), 1879.

Corallum small, thin, frondescient, celluliferous on both sides, varying from one-half to one line thick; surface smooth; calices slightly oblique to the surface with somewhat elongate apertures, nearly equal in size, circular or oval, arranged in diagonal lines and eight to ten in one line; interstitial cells few; corallites short,

approaching the surface in a regular curve, with remote tabulæ in the axial and more numerous ones in the peripheral region; tabulæ horizontal and vesicular, in the latter event connected by horizontal lines with the opposite side. (Jour. Cin. Soc. Nat. Hist., vol. 2, 1879, p. 27, as *Chetetes compressus* and in Ibid., vol. 5, 1882, p. 244, as *Peronopora compressa*.)

Locality.—Cincinnati, O.

56.—M. STIDHAMI Ulrich (sp.), 1890.

Corallum irregularly lobate or massive; surface smooth with clusters of somewhat larger cell apertures; corallites radiating in all directions from a point at the base; angular, irregular in shape and thin-walled throughout; from eight to ten in two mm.; tabulæ horizontal, about a tube diameter apart; spiniform corallites rather large, numerous, and situated at the angles of the corallites. (Geol. Sur. of Ills., vol. 8, 1890, p. 456, as *Leptotrypa stidhami*.)

Locality.—Brown County, Ohio.

57.—M. UNIFORMIS Ulrich (sp.), 1882.

Corallum of erect, flattened, smooth or undulating expansions, several inches in height, varying from one to three lines in thickness; composed of two layers of cells growing in opposite directions from the median plate; cells polygonal, sub-equal, thin-walled, averaging $\frac{1}{100}$ inch in diameter; interstitial cells almost entirely wanting, usually restricted to small clusters or irregularly scattered among the ordinary cells; corallites thin-walled, lying prostrate at first but soon bending and proceeding directly to the surface, the walls becoming there moderately thickened; straight tabulæ in a few corallites, but wanting in most of them, being replaced by vesicular diaphragms; spiniform tabuli few and small, mostly at angles of junction of cells. (Jour. Cin. Soc. Nat. Hist., vol. 5, 1882, p. 244, as *Peronopora uniformis*.)

Locality.—Cincinnati, O.

58.—M. WILMINGTONENSE Ulrich (sp.), 1890.

Corallum compressed, sub-ramose; surface smooth; corallites slightly inclined in the axial region, turning to the surface with a sharp curve; calices four in one mm., circular, about 0.2 mm. in diameter, nearly always surrounded by interstitial corallites about as long

as the corallites proper; walls but little thickened in the cortical region; tabulæ few near cortical region in ordinary corallites but numerous in the interstitial ones; spiniform corallites small and inconspicuous. (Geol. Sur. of Ills., vol. 8, 1890, p. 426, as *Leioclema wilmingtontense*.)

Locality.—Wilmington, Ills.

59.—M. SINGULARIS Ulrich (sp.), 1890.

Corallum "sub-ramose," sometimes seven cm. thick; surface smooth or nearly so, with clusters of cells slightly larger than the average; corallites nine in two mm., angular and thin-walled in the axial, sub-circular in the mature region; interstitial cells numerous, variable in size, angular or sub-circular; tabulæ irregular in numbers, sometimes few in the cortical and wanting in the axial region, at others present in the axial and closely set in the peripheral region; generally "horizontal, often concave, sometimes infundibular and occasionally simulate cystisphragms [vesicles] if they are not of that nature;" spiniform corallites very numerous, inflecting the visceral cavity and giving it a petaloid appearance. (Geol. Sur. of Illinois, vol. 8, 1890, p. 415, as *Heterotrypa singularis*; also Pal. of Minn., vol. 3 of Geol. and Nat. Hist. Survey, 1893, p. 268.)

Locality.—Wilmington, Ills., and Wisconsin.

60.—M. INFLECTA Ulrich (sp.), 1890.

Corallum frondescant, about four cm. wide, six cm. long and three to five mm. thick; surface smooth or with slight elevations with cell apertures larger than the average: corallites bending abruptly into the cortical region; walls slightly flexuous in the axial portion; calices circular, about eight in two mm.; numerous interstitial corallites, which are more abundant in the clusters; tabulæ only one or two in each tube, but numerous in the interstitial cells; spiniform corallites present, frequently indenting the visceral cavity, and giving the surface a hirsute appearance. (Geol. Sur. Illinois, vol. 8, 1890, p. 414, as *Heterotrypa inflecta*.)

Locality.—Cincinnati, O.

GROUP V. *Incrusting or parasitic*: Forming patches or crusts of greater or less extent and growing on various species of shells or corals.

a. Corallum forming a thin crust.

* Surface with elongated monticules..... 61

* Surface with rounded or conical monticules. 62, 63, 64, 65

* Surface smooth:

† With groups of cells larger than average..... 66, 67

† Without groups of larger cells..... 68

b. Corallum forming irregular masses about crinoid columns.. 69

c. Corallum fusiform or clavate..... 70, 71

d. Corallum sub-globular or irregular..... 72

e. Corallum forming well-defined, generally small patches. 73, 74

f. Corallum hemispheric or conical..... 75, 76

61.—M. TUBERCULATA Edw. & H. (sp.), 1851.

Corallum parasitic, forming a more or less extensive crust, from one-fourth of a line to two lines thick, ordinarily about one-half a line, attached to the outer surfaces of shells of *Orthoceras* and *Endoceras*; surface with a number of long and narrow or rounded monticules, arranged with more or less regularity in diagonal lines, and with their longer diameter in the same direction as the long axis of the shell upon which they grow; summits generally compact; calices small, polygonal, nearly equal in size, with occasionally a few interstitial corallites; walls of calices rather thick at the surface, thinner beneath, sometimes bearing on their margins one or two rows of minute tubercles; tabulæ when developed, complete. (Pol. Foss. des Terr. Pal., 1851, p. 268, as *Chætetes*; Nicholson, Genus Montic., 1881, p. 200.) (*Chætetes corticans* Nicholson, Quart. Jour. Geol. Soc. Lond., vol. 30, 1874, p. 512; *Atactapora hirsuta* Ulrich, Jour. Cin. Soc. Nat. Hist., vol. 2, 1879, p. 120; *Ibid.*, vol. 6, 1883, p. 245; *A. maculata* Ulrich, *Ibid.*, vol. 2, 1879, p. 121; vol. 6, 1883, p. 246; *Spatiopora montifera* Ulrich, *Ibid.*, vol. 6, 1883, p. 168.)

Locality.—Cincinnati and various places in Warren, Butler and Clinton counties, Ohio.

Remarks.—The differences which are relied upon by Mr. Ulrich to separate *Atactapora hirsuta* and *A. maculata* from the present species we do not believe to be sufficient to justify such separation. The same

may be said in regard to *Spatiopora montifera*. Mr. Ulrich considers this to be separated from other, similar species, by its well developed monticules.

62.—M. ORTONI Nicholson, 1874.

Corallum forming a very thin crust parasitic on shells of *Orthoceras*, *Strophomena*, and fronds of various corals, varying from one-ninth to three-fourths of a line thick, and rarely more than one inch in diameter; surface with numerous rounded or conical monticules, more or less regularly distributed, from one-half a line to a line or more apart, and either solid or bearing calices of the ordinary size; calices irregular in shape, often indented by one or more tooth like or blunt projections; $\frac{1}{12.5}$ inch in their longer diameter; margins varying in different examples from thin to very thick, and generally studded with small tubercles, giving the surface a granular appearance; interstitial cells more or less numerous; in the centre of the corallum, the corallites are often nearly vertical to the surface of attachment, but becoming inclined and opening by oblique apertures at the surface; tabulæ mostly concave or horizontal and fairly numerous, becoming at times incomplete and vesicular at the mouths of the calices. (Quart. Jour. Geol. Soc. London, vol. 30, 1874, p. 513, under *Chætetes*; Genus Montic., 1881, p. 228.) (*Atactopora multigranosa* Ulrich, Jour. Cin. Soc. Nat. Hist., vol. 2, 1879, p. 122; *Atactoporella multigranosa* Ulrich, *Ibid.*, vol. 6, 1883, p. 254; *Atactopora mundula* Ulrich, *Ibid.*, vol. 2, 1879, p. 123; *Atactoporella mundula* Ulrich, *Ibid.*, vol. 6, 1883, p. 252; *Atactopora tenella* Ul., *Ibid.*, vol. 2, 1879, p. 123; *Atactoporella schucherti* Ulrich, *Ibid.*, vol. 6, 1883, p. 251; *Atactoporella typicalis* Ul., *Ibid.*, vol. 6, p. 248.)

Locality.—Cincinnati, Oxford, etc., Ohio; Covington, Ky.; Delafield, Wis., etc.

Remarks.—The synonymy of this species as given above seems to be somewhat startling. It is the belief of the writer, however, that it is necessary to reduce the so-called species to the rank of synonyms. The changes made by Mr. Ulrich from one genus to another have not made matters any better. There does not seem to be any better way of showing the resemblances between all of the forms than by putting them in parallel columns, which is done below:

ORTONI.	MULTIGRANOSA	MUNDULA.	TENELLA.	SCHUCHERTI.	TYPICALIS.
<i>Corallum.</i> Parasitic: $\frac{1}{9}$ to $\frac{3}{4}$ of a line thick.	Parasitic: $\frac{3}{4}$ of a line thick.	Parasitic: $\frac{1}{2}$ of a line thick.	Parasitic: $\frac{1}{4}$ to $\frac{1}{2}$ of a line thick.	Parasitic: $\frac{1}{3}$ of a line thick.	Parasitic: $\frac{3}{10}$ of a line thick.
<i>Surface.</i> Rounded or conical monticules, solid or with calices of ordinary size; calices indented by small tubercles presenting a floriform appearance.	Small conical monticules, regularly arranged with calices slightly, if at all, larger than the average; cell apertures indented and more or less floriform.	More or less conical monticules, with the calices slightly larger than the average; cell apertures rounded, more or less indented.	Low and broad monticules with cells slightly larger than average; cell apertures oval or sub-rhomboidal indented by spines.	Small "eminences" slightly raised; cell apertures rounded and with many indentations made by projections of large spines.	Groups of cells slightly larger than the average raised into low, rounded monticules or level with the surface; cell apertures floriform regularly arranged in diagonal lines.
<i>Corallites.</i> Walls varying from thin to very thick: cells $\frac{1}{25}$ inch in diameter.	Walls thin; cells $\frac{1}{20}$ inch in diameter.	Walls thin; cells $\frac{1}{20}$ inch in diameter.	Walls thin; cells $\frac{1}{80}$ inch in diameter.	Walls thin; cells $\frac{1}{150}$ inch in diameter.	
<i>Interstitial cells.</i> Present and more or less numerous.	Present, but difficult to detect owing to increase of sclerenchyma.	Present and numerous.	Present: not so numerous as in <i>mundula</i> .	Present and numerous, unequal in size.	Present and quite numerous, angular.
<i>Tabulae.</i> Mostly horizontal, and fairly numerous, becoming at times incomplete and vesicular.	Mostly horizontal, but incomplete and vesicular in some parts.	Many horizontal, but vesicular ones also present.	Unknown.	Many horizontal, but the vesicular ones also developed and to about the same degree.	Many horizontal, but in places incomplete and vesicular.

63.—M. PAPILLATA McCoy, 1850.

Corallum forming very thin layers, parasitic on brachiopods, *Orthoceras*, etc., generally about one-half a line thick; surface with conical or rounded monticules, arranged with more or less regularity, a little wider than high, usually about twice their diameter apart, this diameter being about half a line; the monticules with cells larger than the average, about ten in each cluster, the smaller cells being about nine or ten in one line; calices polygonal, thin walled, bearing in well preserved examples a small number of spiniform tubuli; no interstitial cells. (Ann. & Mag. of Nat. Hist., 2d ser., vol. 6, 1850, p. 284, as *Nebulipora*. Nicholson, Pal. of Ohio, vol. 2, 1875, p. 210.)

Locality.—Cincinnati and Hamilton, Ohio.

64.—M. PARASITICA Ulrich, 1882.

Corallum parasitic, usually attached to *Streptelasma*, varying in thickness up to one line, two or more patches frequently coalescing and leaving a ridge between them; surface with conical monticules, regularly arranged in decussating series, the summits usually appearing to be solid, but really occupied by minute cells, the cells on the slopes with apertures slightly larger than the average; interspaces with polygonal and moderately thin-walled cells; interstitial cells only on the monticules; corallites thin walled and polygonal, usually thickened at the angles of junction where spiniform tubuli occur; walls with a granular appearance; tabulæ forming vesicles upon one or both sides of the tubes, with horizontal tabulæ extending across the intervening space. (Jour. Cin. Soc. Nat. Hist., vol. 5, Dec., 1882, p. 238.)

Locality.—Oxford, Ohio.

65.—M. ASPERULA Ulrich, 1883.

Corallum parasitic, consisting of thin, sub-circular expansions, two to five lines in diameter, and 0.3 to 0.8 of a line in thickness; surface with small, conical monticules, arranged in regular intersecting series, occupied by cells slightly, if at all larger than the ordinary ones; generally the apices are occupied by one or several spiniform tubuli, often considerably larger than those in the intervening spaces; calices small and unequal in size; walls of corallites thin; tabulæ wanting; angles of junction of cell walls occupied by very large and

prominent spiniform tubuli, larger in the groups or monticules than over the general surface. (Jour. Cin. Soc. Nat. Hist., vol. 6, 1883, p. 157, as *Petigopora asperula*.)

Locality.—Cincinnati, Ohio, and Covington, Ky.

66.—*M. CRUSTULATA* James, 1878.

Corallum forming a thin crust, parasitic on shells of *Orthoceras* and other substances, and from one-eighth of a line to one-fourth of a line thick; surface generally smooth, sometimes with a few small elevations; calices sub-polygonal, rounded or oblong, varying in form and size; at intervals of about two lines are groups of larger cells, sometimes the center one larger than the rest; walls of corallites very thin, sometimes bearing numbers of spiniform corallites; no interstitial cells. (The Paleontologist, July, 1878, and January, 1879, pp. 1, 20, as *Chetetes*.) (*Leptotrypa ornata* Ulrich, Jour. Cin. Soc. Nat. Hist., vol. 6, 1883, p. 160; *L. clavis*, Ulr., *Ibid.*, p. 161; *L. cortex* Ulr., *Ibid.*, p. 162; *Spatiopora lineata* Ulr., *Ibid.*, p. 167.)

Locality.—Cincinnati and Hamilton, Ohio.

Remarks.—With this species as with *M. ortonii* the synonymy may seem excessive. But a careful comparison of the descriptions of Mr. Ulrich has not made it possible to draw any distinguishing lines between them. Perhaps *Spatiopora lineata* might be separated, as in this the cells seem to be all of one size without clusters of larger ones, and they are arranged in regular lines. Otherwise there is no difference to be observed. The tabulæ are not numerous and are horizontal.

67.—*M. ASPERA* Ulrich (sp.), 1883.

Corallum parasitic, forming large and thin expansions, attached to species of *Orthoceras*, and about .5 line thick; surface smooth, with clusters of cells larger than the average; calices oblong, varying in size from $\frac{1}{110}$ of an inch to $\frac{1}{55}$ of an inch in diameter; walls thin, with spiniform corallites more or less numerous at the angles of the cells; cell walls frequently indented; tabulæ wanting. (Jour. Cin. Soc. Nat. Hist., vol. 6, 1883, p. 166, as *Spatiopora aspera*.) (*Spatiopora maculosa* Ulr., *Ibid.* p. 167.)

Locality.—Cincinnati, Hamilton and other points in Ohio.

Remarks.—The two species united above are so similar as not, in the opinion of the writer, to justify a separation. The only distinc-

tions given by Mr. Ulrich are the smaller and less prominent spiniform corallites and the more conspicuous groups of larger cells in *S. maculosa*. The former are to be observed only on finely preserved specimens.

68.—*M. LAMELLOSA* Ulrich, 1890.

Corallum parasitic, of one or more layers, each one to four or five mm. thick; surface smooth, showing projecting spiniform corallites; walls of corallites thin below but slightly thickened at the surface; calices eight in two mm., angular; tabulæ horizontal, with a few vesicular ones; spiniform corallites moderately numerous, increasing in size toward the surface. (Geol. Sur. Illinois, vol. 8, 1890, p. 408.)

Locality.—Wilmington, Ills.

Remarks.—This is one of the many recent new species described by Mr. Ulrich. The description is not as complete as many given by that author and it is somewhat difficult to make comparison with other forms. It seems nearly related to *M. crustulata* and to *M. aspera*.

69.—*M. DYCHEI* James, 1882.

Corallum sub-fusiform in outline, parasitic on a crinoid column, with rough, nodular swellings, low ridges and annular constrictions; tapering at each end to a little more than the size of the stem upon which it is growing; surface with slightly raised, rounded monticules, irregularly distributed, and occupied by calices slightly larger than the average; corallites radiating from the central object, slightly inclined at first and then curving directly to the outer surface; calices polygonal, eight to ten in one line with thin and sharp edges; tubes with thin walls, angular, and with a few, remote, horizontal and complete tabulæ; interstitial cells wanting. (The Paleontologist, No. 6, Sept. 12, 1882, p. 56; Jour. Cin. Soc. Nat. Hist., vol. 6, 1883, p. 235.)

Locality.—Lebanon, O.

70.—*M. FUSIFORMIS* Whitfield (sp.), 1877.

Corallum cylindrical, sub-fusiform, straight or curved, pointed or blunt at one or both ends; a few specimens with a projection at one end, but not like a base; one-fourth of an inch to an inch long, and from one-half a line to one and one-half lines in diameter; surface

smooth; calices very small, oval or sub-circular, without any regular arrangement, ten or twelve in one line; intercellular spaces marked by scattered pits, by a depressed groove, or by an elevated, ridge-like line; walls of corallites tolerably thick; corallites more or less polygonal, separated by spaces with very fine lines; cell walls in the axial region very thin, somewhat tortuous until the surface is approached where they open obliquely; no tabulæ in the central portion, but near the surface closely but faintly tabulate; in transverse section the corallites in the central portion have a chain-like or reticulated appearance. (Ann. Rept. Geol. Sur. Wisc., 1877, p. 70, as *Chætetes*. Geol. of Wisc., vol. 4, 1882, p. 248.) (*M. subfusiformis* James, The Paleontologist, No. 6, 1882, p. 52.)

Locality.—Warren and Clinton Counties, Ohio; Iron Ridge, Wisconsin.

Remarks.—The above was originally described from rocks of the Hudson River group in Wisconsin, at Iron Ridge. The form described as *M. subfusiformis* U. P. James, is evidently the same. Prof. Whitfield does not describe the internal structure, and this is taken from Mr. James's description of *M. subfusiformis*.

71.—*M. CLAVACOIDEA* James, 1875.

Corallum forming a crust and generally cylindrical, clavate or fusiform, receiving its shape from the tapering ends of small species of *Orthoceras* or other cylindrical objects, to which it is attached by the whole of its base; surface either smooth or elevated into low monticules, occupied by tubes slightly larger than the average; calices polygonal, nearly equal in size; no interstitial cells; corallites thin walled and directed at right angles to the base; tabulæ when present complete and horizontal, but absent in the greater part of the corallites; corallites increased in numbers by the interpolation of new ones. (Cat. Foss. Cin. Gr., 1871 (named only); Cat. Low. Sil. Fos., 2nd ed., 1875, p. 1, as *Chætetes clavacoideus*. (*Leptotrypa minima* Ulrich, Jour. Cin. Soc. Nat. Hist., vol. 6, 1883, p. 159.)

Locality.—Cincinnati, O.

Remarks.—The species described by Mr. Ulrich as *Leptotrypa minima* does not seem to present a sufficient number of characters to justify its separation. In point of fact the description given for it would fit almost exactly the species described by Mr. James as *Monticulipora clavacoidea*. It might be well to state here that Mr.

Ulrich's genera are founded in many cases upon such indefinite characters that the fact of a species being placed by him in another genus does not militate against its being considered a synonym of some species here regarded as *Monticulipora*.

72.—*M. LÆVIS* Ulrich, 1882.

Corallum free or attached to some foreign substance, sub-globular or irregular in outline; surface smooth or with a few low and broad monticules, occupied by cells a little larger than the average; corallites thin-walled in immature portion and crossed by straight or oblique tabulæ, a few of them with vesicles on one side; in mature portion walls slightly thickened, with a larger number of vesicles and more numerous straight tabulæ; tubes polygonal, the visceral chamber crossed by a lamina excavated in a triangular or concentric manner; small number of interstitial cells. (Jour. Cin. Soc. Nat. Hist., vol. 5, Dec. 1882, p. 236.)

Locality.—Oxford, O.

Remarks.—This species, while differing in outward aspect from *M. consimilis* Ulr., (See No. 16 *M. cincinnatiensis*.) has exactly the same internal structure. If separated it must be by the external form.

73.—*M. VERRUCOSA* n. sp.

Corallum parasitic, forming patches of greater or less extent, the edges being inclined to turn up; surface with small, conical monticules about two mm. apart, more or less sub-solid at the apex and arranged in diagonal intersecting rows; calices circular, about nine in two mm.; interstitial cells present, more numerous in the monticules; internal structure unknown. (Geol. Sur. Illinois, vol. 8, 1890, p. 418, as *Calloporella? nodulosa*.)

Locality.—Savannah, Ills.

Remarks.—The name given by Mr. Ulrich, *nodulosa*, having been applied to a species of *Monticulipora*, it becomes necessary on the transfer of the species to this genus to give it a new name. Therefore that given above is proposed. The original *M. nodulosa* is a branching form, while this species is parasitic.

74.—*M. PETECHIALIS* Nicholson, 1875.

Corallum forming small circular patches, from less than one-half a line to a line and one-half in diameter, attached parasitically to

foreign bodies, generally the shells of brachiopods (*Strophomena alternata*, etc.); more or less convex above; surface generally smooth, but often with a single central elevation; calices sub-circular, mostly equal, with moderately thick walls; no interstitial cells (Pal. of Ohio, vol. 2, 1875, p. 213, as *Chætetes*.)

Locality.—Cincinnati, O.; Kentucky and Minnesota.

Remarks.—This peculiar little species can scarcely be mistaken for any other. “It is questionable whether it may not be the base of some other species, possibly the young corallum of some incrusting form like *M. papillata*. Nicholson, indeed, makes such a suggestion but does not think it likely. He says further that ‘at any rate in the absence of any specimen by which this could be directly connected with any other known form, I have thought it best to place it under a separate title, since it is not only common in its occurrence, but is also very constant in its size and other characters.’” Mr. Ulrich has placed it in his genus *Petigopora*. I have not been able to find any description of its internal microscopic characters.

75.—*M. SELWYNII* Nicholson, 1881.

Corallum varying from $1\frac{3}{4}$ to $3\frac{1}{2}$ inches in diameter and about one-half inch high in the centre; discoid or conical, base flat or concave, covered by a concentrically striated epitheca; corallites of two kinds, larger oval or irregularly circular, $\frac{1}{60}$ to $\frac{1}{50}$ inch in diameter, smaller, interstitial ones, angular or sub angular, from $\frac{1}{200}$ to $\frac{1}{150}$ inch in diameter, and collected at intervals into maculæ; surface smooth; tabulæ in larger tubes more or less convex and forming a series of vesicles on one side of the chamber, while others run from these across to the opposite side, or across directly from side to side; tabulæ in the small tubes numerous, closely set, complete and horizontal. (Genus Montic., as *Prasopora*, 1881, p. 206.) (*Prasopora simulatrix* Ulrich, 14th Ann. Rept. Minn. Geol. & Nat. Hist. Sur., 1886, p. 85.)

Locality.—Canada, Minnesota, Kentucky and Tennessee. (Trenton.)

Remarks.—There are not enough differences between Nicholson’s *selwynii* and Ulrich’s *simulatrix* to justify a separation. Although this is a Trenton species it is inserted here with the idea of its possible occurrence in the Cincinnati group. Nicholson’s *M. (Prasopora) selwynii* var. *hospitalis* is the same as *M. turbinata* James. This was

suspected at the time the description of this species was published in this series of papers (see No. 2) but examination of the internal structure places it beyond doubt. This internal structure is almost identical with *M. selwynii* given above, so it need not be repeated here.

76.—*M. WINCHELLI* James, 1882.

Corallum sub-circular in outline, spreading to a thin edge, and dome-shaped above; base attached to foreign bodies; surface showing maculæ or small monticules with calices slightly larger than the average; corallites thin walled, curving slightly outward or at times direct to the surface; apertures oval, polygonal, or sub-circular, eight or ten in one line; interstitial cells more or less numerous; angular and varying in form; spiniform corallites numerous; in vertical section tube walls vary in thickness and may sometimes be duplex; tabulæ complete and horizontal or passing across from one side to the other at varying angles. (The Paleontologist, Sept. 12, 1882, p. 48.) (*Non M. winchelli* Ulr.)

Locality.—Lynchburg, Ohio.

Remarks.—In a previous paper by U. P. & J. F. James already quoted, this species was placed as a synonym of *M. hospitalis* Nicholson. This view does not seem any longer tenable and it is restored to specific rank. The *M. winchelli* of Mr. Ulrich is from the Hamilton group of Michigan and will need to be given a new name. It was described in Geol. Sur. of Illinois, vol. 8, 1890, p. 408. It is a parasitic species but of an entirely different character from the present form. It might, perhaps, be called *M. hamiltonense*.

GROUP VI. Apparently free growing and of anomalous shape. There is only one species referred here:

a. Shaped like a small wooden shoe 77

77.—*M. CALCEOLA* Miller & Dyer, 1878.

Corallum free, of rather small size, helicoid in form, and varying from one line to six lines in diameter; surface smooth or covered with low rounded monticules; interior traversed by a horn-shaped cavity lined on the inside by encircling striæ, and varying from one-half a line to more than two lines in diameter; calices approximately equal, polygonal, more or less regularly arranged; corallites radiating from

the basal epitheca to the outer surface; walls thin; small spiniform corallites at the angles of junction of the corallites; tabulæ fairly well developed, complete and horizontal, increasing in numbers toward the surface. (Jour. Cin. Soc. Nat. Hist., vol. 1, 1878, p. 26; Nicholson, Genus Montic., 1881, p. 185.)

Locality.—Cincinnati, O.

Remarks.—This is a peculiarly shaped species and one very readily recognized. It was compared originally by its describers to a “little wooden shoe.” They “suppose it to have begun from an embryo or a ciliated animalcule floating free in the water, and giving rise to a colony by gemmation from either side and from one end, leaving the other as a central tube or cavity.” It is not generally considered as taking its form by growing parasitically upon any foreign body.

(To be continued.)

CATALOGUE OF LAND AND FRESH WATER SHELLS
FOUND IN THE VICINITY OF CINCINNATI
PREPARED FOR THE USE
OF BEGINNERS.

BY GEORGE W. HARPER, A. M.

CLASS GASTEROPODA.

ORDER PULMONIFERA.

FAMILY PHILOMYCENIDÆ.

GENUS TEBENNOPHORUS.

1. *Tebennophorus carolinensis*, *Bosc.*
Large *slug marbled* with black and brown. Under logs.

FAMILY LIMACIDÆ.

GENUS LIMAX.

2. *Limax maximus*.
Large slug, alternate rows of spots and black stripes.
3. *Limax agrestis*, *Mull.* 4.
Dark colored, one inch long. Everywhere.
4. *Limax campestris*, *Binn.*
Resembles No. 3 but does not secrete mucus. Everywhere.

FAMILY HELICIDÆ.

GENUS MESODON.

Distinguished by well-developed lip which is devoid of teeth.

Width of 5, 6, 7, 8, 9, 10 about one inch.

5. *Mesodon abolabris*, *Say.* 6, 7.
Outer lip elongated, umbilicus covered. Woods.
6. *Mesodon exolæta*, *Binn.* 7.
Resembles No. 5. Mouth rounded, and small tooth on parietal wall (pillar lip). Woods.

7. *Mesodon thyroides*, Say.

Resembles No. 6, but umbilicus partly covered. Everywhere abundant.

8. *Mesodon multilineata*, Lea.

Beautifully marked with brown longitudinal lines. Woods near river banks.

9. *Mesodon elevata*, Say.

White, spire elevated, large tooth on parietal wall. Wooded hillsides.

10. *Mesodon profunda*, Say.

Brown stripes, open umbilicus, tooth-like projection on outer lip near base. Woods.

Width of 11, 12, 13 about one-half inch.

11. *Mesodon pennsylvanica*, Green.

Brown, outer lip elongated. In sedge and thicket.

12. *Mesodon mitchelliana*, Lea.

White, umbilicus covered. River bottoms.

13. *Mesodon clausa*, Say.

White, umbilicus partly covered. River bottoms.

GENUS TRIODOPSIS.

Distinguished by the three teeth, one on body or parietal wall, and two on outer lip or peristome.

Width of 14, 15, 16, 17, 18 about three-quarters of an inch.

14. *Triodopsis palliata*, Say. 15.

Dark, hirsute, two teeth on outer lip, one long tooth on parietal wall. Under logs.

15. *Triodopsis appressa*, Say.

Smaller than No. 14 and not hirsute. Stone walls.

16. *Triodopsis tridentata*, Say. Rock variety. 17.

White. Rocky places.

17. *Triodopsis tridentata*, Say. Woods variety.

Brown and smaller than No. 16. Woods.

18. *Triodopsis fallax*, Say, 19.

Two teeth on outer lip turn inward. Wooded hillsides.

19. *Triodopsis inflecta*, Say.

Half size of No. 18, umbilicus covered. Wooded hillsides.

GENUS VALLONIA.

20. *Vallonia minuta*, Say.
Size of pin head, lipped, open umbilicus. Rocky places.
21. *Vallonia costata*, Mull.
Size of pin head, lipped, open umbilicus, ribbed. Rocky places.

GENUS STENOTREMA.

22. *Stenotrema hirsuta*, Say. 23, 24.
Brown, hirsute, long tooth on parietal wall, notch on outer lip,
width less than half inch. Found everywhere.
23. *Stenotrema stenotrema*, Fer.
Like No. 22, but over twice as large. Woods.
24. *Stenotrema monodon*, Rack.
Similar to No. 22, but without notch in outer lip. Damp places.

GENUS PATULA.

25. *Patula alternata*, Say. 26.
W. 1, No lip, beautifully marked with oblique rows of brown
blotches. Everywhere abundant.
26. *Patula solitaria*, Say.
W. 1 and over. Higher apex than No. 25, with regular longitu-
dinal brown stripes. Thickets.
27. *Patula perspectiva*, Say.
W. over $\frac{1}{4}$, widely open umbilicus. Under bark and logs.
28. *Patula striatella*, Anth.
W. less than $\frac{1}{4}$, umbilicus not so wide and not as brown as No.
27. Lumber yards near water.

GENUS ZONITES (*Montf.*).

Genus Hyalina (*Gray*).

The distinction between the genus *Zonites* and the genus *Hyalina* is not fully determined. Both genera have little or no perceptible thickening of the lip, with a glossy epidermis.

29. *Zonites fuliginosus*, Griff.
W. 1, dark. Woods.

30. *Zonites laevigatus*, *Pfeiffer*. 31.
W. $\frac{3}{4}$, light green. Beds of leaves.
31. *Zonites inornatus*, *Say*.
Like No. 30, except it is flatter. Beds of leaves.
32. *Zonites* or *Hyalina ligera*, *Say*. 42.
W. $\frac{1}{2}$, light green, white on inside of lip, apex elevated. Rocky places.
33. *Zonites* or *Hyalina arboreus*, *Say*. 35, 41.
Brown, less than $\frac{1}{4}$ inch, shell thin. Decaying logs.
34. *Zonites* or *Hyalina suppressus*, *Say*. 36, 37.
W. less than $\frac{1}{4}$, shell thin, one or two elongated teeth extending deeply within the peristome near the base.
35. *Zonites* or *Hyalina nitida*, *Mull*.
Like, but larger than No. 33. Lumber yards near water.
36. *Zonites* or *Hyalina interna*, *Say*. 37.
Brown, thicker than No. 34, two or three rows of round white teeth seen through the shell. In decayed logs.
37. *Zonites* or *Hyalina multidentata*, *Binn*.
Teeth and shell like No. 36, but very much smaller. Under damp leaves in ravines.
38. *Zonites* or *Hyalina fulva* or *chersina*, *Say*. 46.
Size of pin head, brown, convex base, apex high. In beds of leaves.
39. *Zonites* or *Hyalina indentata*, *Say*.
Thin, pelucid, lines of growth prominent. Under stones and leaves.
40. *Zonites* or *Hyalina limatula*, *Ward*. 43, 47.
White, waxy color, flat open umbilicus. Under bark of logs.
41. *Zonites* or *Hyalina viridula*, *Neke*.
Like No. 33, but peristome thicker, very shiny and lighter color. Under leaves in ravines.
42. *Zonites* or *Hyalina intertexta*, *Binn*.
W. $\frac{1}{2}$, like No. 32, but has a light-colored longitudinal stripe on body whirl, and is more carinate. At mouth of Big Miami.
43. *Zonites* or *Hyalina minuscula*, *Binn*. 47.
Like No. 47, but very minute. Under rocks or wood.

GENUS *HELICODISCUS* (*Morse.*)

44. *Helicodiscus lineatus*, *Say.*

Small disk, fine longitudinal lines on outer whirl, two pairs of teeth within peristome. On dead wood.

GENUS *MACROCYCLIS* (*Beck.*)

45. *Macrocyclus concava*, *Say.*

W. $\frac{3}{4}$ pale, wide umbilicus, lip slightly thickened. Found everywhere.

GENUS *STROBILA*.

46. *Strobila labyrinthica*, *Say.*

Like No. 38, but more conical, small tooth on peristome and long tooth running far into the shell, open umbilicus, brown, ribbed and lipped. Under bark of half decayed logs.

GENUS *PUNCTUM*, (*Morse.*)

47. *Punctum minutissimum*, *Lea.*

Like No. 43 but smaller, apex higher, very minute. Under leaves.

GENUS *CIONELLA*.

48. *Cionella subcylindrica*, *Binn.* 50, 51.

H. $\frac{1}{4}$, lip and shell very shiny. Damp roadsides. A larger variety occurs in woods.

GENUS *PUPA*, (*Dr.*)

GENUS *LEUCOCHILA*.

49. *Pupa* or *Leucochila armifera*, *Say.*

White, H. 3-16 oblong-oval lip reflected, aperture round cup form, four or more irregular teeth. Rocky places.

50. *Pupa* or *Leucochila fallax*, *Say.*

Like No. 48, but smaller and dull brown. Under stones.

51. *Pupa* or *Leucochila rupicola*, *Say.*

Brown, smaller than No. 50 and more cylindrical, tooth on parietal wall. Rocky places.

52. Pupa or *Leucochila contracta*, *Say*, 54, 55, 56, 57.
Like No. 49, but smaller, mouth more triangular. Rocky places.
A larger variety occurs in woods.
53. Pupa or *Leucochila corticaria*, *Say*.
Like No. 52, but only one tooth on pillar lip. Under bark of
half decayed logs.
54. Pupa or *Leucochila pentodon*, *Say*, 55, 56, 57.
White, smaller than No. 52, peristome expanded but not reflexed,
one tooth on parietal wall, four or more on outer lip. Rocky
places.

GENUS VERTIGO, (*Mull.*)

55. *Vertigo milium*, *Gould*, 56, 57.
Like No. 54, but brown, very small. Beds of leaves.
56. *Vertigo ovata*, *Say*.
Like No. 55, larger and more darkly brown. Beds of leaves.
57. *Vertigo simplex*, *Gould*.
Like No. 55, but no teeth. Beds of leaves.

FAMILY SUCCINIDÆ.

GENUS SUCCINEA.

58. *Succinea avara*, *Say*, 59, 60, 61,
Pale reddish yellow, height $\frac{1}{2}$ inch. River banks.
59. *Succinea ovalis*, *Gld*.
Longer and broader at base than No. 58.
60. *Succinea vermeta*, 61.
Light colored, smaller variety of No. 58.
61. *Succinea aurea*, *Lea*.
Like No. 60 but of a more highly golden color. River banks.
62. *Succinea obliqua*, *Say*.
Light yellowish green, height $\frac{3}{4}$ -inch. River banks.

SUB-ORDER LIMNOPHILA.

FAMILY AURICULIDÆ.

GENUS CARYCHIUM.

63. *Carychium exiguum*, *Say*.
Very thin and small, elongated, white transparent, small tooth on
columella.

FAMILY LIMNÆIDÆ.

SUB-FAMILY LIMNÆINÆ.

GENUS LIMNÆA.

Spire elevated and shell of pale dirty color.

- 64. *Limnæa* (*Radix*) *columella*, *Say*.
H. 7-16, very variable.
- 65. *Limnæa* (*Limnophysa*) *humilis*, *Say*.
H. 5-16, Like No. 67, but smaller.
- 66. *Limnæa* (*Limnophysa*) *reflexa*, *Say*.
H. 1 1/8, largest found in this vicinity.
- 67. *Limnæa* (*Limnophysa*) *decidiosa*, *Say*, 65.
H. 9-16, brownish, facets on body white.

GENUS PHYSA.

- 68. *Physa heterostropha*, *Say*, 69, 70.
Shell reversed, glassy surface.
- 69. *Physa ancillaria*, *Say*.
Larger than No. 68, spire shorter.
- 70. *Physa gyrina*, *Say*.
Larger than No. 68, longer shell and spire.

SUB-FAMILY PLANORBINÆ.

GENUS PLANORBIS.

- 71. *Planorbis* (*Helisoma*) *trivolvus*, *Say*, 72, 73, 74.
W. 5-6, Disk shape, concave on upper and lower sides.
- 72. *Planorbis* (*Helisoma*) *bicarinatus*, *Say*, 74.
Like No. 71, but sharply carinate.
- 73. *Planorbis glabrus*, *Say*.
Larger than No. 71 and flatter.
- 74. *Planorbis lentus*, *Say*.
Like No. 72 but carinate only on upper side.
- 75. *Planorbis* (*Gyrulus*) *parvus*, *Say*.
Small, broadly concave on underside.

GENUS SEGMENTINA.

- 76. *Segmentina armigera*, *Say*.
W. 5-16, six white teeth far within the throat.

SUB-FAMILY ANCYLINÆ.

GENUS ANCYLUS.

77. *Ancylus rivularis*, Say.
Small scale like narrow at one end.
78. *Ancylus tardus*, Say.
Same width at both ends.

OPERCULATA.

FAMILY VALVATIDÆ.

GENUS VALVATA.

79. *Valvata tricarinata*, Say.
W. 3-16. Three carina.

FAMILY VIVIPARIDÆ.

GENUS MELANTHO.

80. *Melantho integra*, Say, 81, 82, 83, 84, 85, 86, 87.
H. $1\frac{1}{2}$, green.
81. *Melantho decisa*, Say.
A variety of No. 80. Apex eroded.
82. *Melantho ponderosa*, Say, 83.
Rounder and heavier than No. 80.
83. *Melantho obesa*, Lewis.
Same shape as No. 82, but not so heavy.

GENUS LIOPLAX.

84. *Lioplax sub-carinata*, Say.
H. $\frac{3}{4}$, light brownish color, carina distinguishes it from No. 80.

FAMILY AMNICOLIDÆ.

GENUS AMNICOLA.

85. *Amnicola Cincinnatiensis*, 86.
Like the young of No. 80, minute.

GENUS SOMATOGYRUS.

86. *Somatogyrus integer*, 87.
Like No. 85, but larger, spire shorter and mouth rounder.

87. *Somatogyrus isogonus*.
Like No. 86, but larger.

GENUS POMATIOPSIS.

88. *Pomatiopsis lapidaria*.
H. $\frac{1}{4}$, slender, brown, no lip or teeth.

FAMILY STREPOMATIDÆ.

GENUS ANCULOSA.

89. *Anculosa costata*, *Anth.*
H. 7-16, dark brown, with two or three raised lines.
90. *Anculosa praerosa*, *Say.*
H. 4-5, sub-globular, horn color, within lip three or more purplish bands.

GENUS GONIOBASIS, (*Mouth always elliptical.*)

91. *Goniobasis depygis*, *Say.* 92, 93.
H. $\frac{3}{4}$, one or two brown stripes.
92. *Goniobasis pulchella*, *Anth.*
Smaller variety of No. 91.
93. *Goniobasis semicarinata*, *Say.*
Like No. 91, but no stripes and more carinated in apex whorles.

GENUS PLEUROCERA, (*Mouth always rhomboidal.*)

94. *Pleurocera canaliculatum*, *Say.* 96.
H. $1\frac{1}{4}$, horn color, grooved longitudinal canal on whirls.
95. *Pleurocera conicum*, *Say.*
Shorter variety of No. 94.
96. *Pleurocera undulatum*, *Say.*
Like No. 94, but spire longer and sharper and wrinkled on base whorl.
97. *Pleurocera labiatum*, *Lea.* 98.
H. .98, pale horn color.
98. *Pleurocera neglectum*, *Anth.*
Like No. 97, but having two brown bands.

CLASS ACEPHALA.

ORDER BRANCHIFERA.

FAMILY UNIONIDÆ.

GENUS SYMPHYNOTA, (*Fer.*)

(Hinge line extended into a wing.)

1. *Symphynota alata*, *Say*.

L. 6 or more, W. 5 from tip of wing. Nacre purple.

2. *Symphynota pressa*, *Lea*.L. 3, H. $1\frac{3}{4}$, compressa, rayed with green.3. *Symphynota gracilis*, *Barn.* 4.L. $5\frac{1}{2}$ and over, H. $3\frac{1}{2}$ and over. In old specimens yellow color.4. *Symphynota laevissima*, *Lea*.L. 6 or less, H. $4\frac{1}{2}$. In old specimens, dark, finely rayed, nacre pink. Wing more extended than in No. 3.

GENUS UNIO.

5. *Unio abrupta* (*orbiculata*), *Say*.

L. 3, H. 2 and over. Dark yellow, two or more dark rays.

Female (♀) shorter and more abrupt than male (♂).6. *Unio Æsopa*, *Green*.L. $2\frac{3}{4}$, H. 2. Light straw color; a row of nodules down middle of shell.7. *Unio anodontoides*, *Lea*.L. $3\frac{1}{2}$ and over, H. $1\frac{1}{2}$, subcylindrical, yellow, female rayed with green stripes.8. *Unio circula*, *Lea*.L. $2\frac{1}{2}$ and less, H. $2\frac{1}{4}$ and less. Dark color.9. *Unio clava*, *Lam*.L. $2\frac{1}{2}$, H. $1\frac{3}{4}$. Very oblique, yellow, rayed with dark green.10. *Unio coccinea*, *Hild*.L. $2\frac{1}{4}$ and over, H. 2 and over. Nacre rich salmon color.11. *Unio cooperiana*, *Lea*.

L. 3, H. 3. Blunt tubercles on lines of growth, which stand out in ridges.

12. *Unio cornuta*, *Barn*.

L. 2, H. 2. One row of two or more blunt tubercles down each side of the shell.

13. *Unio crassidens*, *Lam.*
L. $2\frac{3}{4}$ and over, H. $1\frac{3}{4}$ and over. Dark, sometimes black, nacre yellow salmon color. Female abrupt on posterior.
14. *Unio crassa*, *Say.*
L. $5\frac{1}{4}$ and over, H. 2 and over. Yellow or dark, rayed with green. Female shorter and more abrupt.
15. *Unio cylindrica*, *Say.*
L. 3 and over, H. $4\frac{1}{4}$ and over. Hinge line straight and and long, under edge of base, concave, noded and wrinkled on posterior part.
16. *Unio donaciforma*, *Lea.*
L. $1\frac{1}{2}$ and over, H. 1 and over. Green covered with zigzag rays.
17. *Unio dorfeuilliana*, *Lea.*
L. $2\frac{1}{4}$ and over, H. $2\frac{1}{2}$ and less. Like No. 11, but not so ridged, has the dark marks near beaks of No. 48, but is covered with pustules up to the beaks.
18. *Unio ebena*, *Lea.*
L. 2 and over, H. $2\frac{1}{2}$ and over. Obliquely circular and generally black.
19. *Unio elegans*, *Lea.*
L. 2, H. 1 5-8. Marked like No. 16, but more triangular and very flat, and abrupt or truncate on posterior part.
20. *Unio ellipsis*, *Lea.*
L. $2\frac{1}{4}$ and less, H. 2 and less. Elliptical, light yellow with darker rays.
21. *Unio fabalis*, *Lea.*
L. $1\frac{1}{4}$, H. $\frac{3}{4}$. Dark brown finely rayed with black.
22. *Unio foliata*, *Hild.*
Female of No. 23—L. $2\frac{1}{4}$, H. 2. Yellow and finely rayed, A broad sulcus or groove runs from beak to margin near posterior end.
23. *Unio flexuosa*, *Raf.*
Male—Sulcus broader and deeper than No. 22, making the lower margin of the shell very irregular.
24. *Unio fragosa*, *Conr.*
L. 3, H. 3 or less. Resembles No. 17, but more pustulate on beaks and a shallow sulcus runs from beaks to margin.

25. *Unio gibbosa*, *Barn.*
L. $2\frac{3}{4}$ and more, H. $1\frac{1}{2}$ or more. Nacre dark purple; when white, called *Unio arctior*, *Lea.* Variety *Unio camelus*, *Lea.*, slopes more abruptly on posterior.
26. *Unio glans*, *Lea.*
L. $1\frac{1}{2}$, H. $\frac{7}{8}$. Dark, finely rayed with black lines.
27. *Unio gouldiana*, *Ward.*
Like No. 10, but has white nacre.
28. *Unio granifera*, *Lea.*
L. $2\frac{1}{4}$, H. $2\frac{1}{4}$ and more. Nacre dark purple, two or more rows of pustules, like No. 67.
29. *Unio iris*, *Lea.*
L. $2\frac{1}{4}$ or less, H. $1\frac{1}{4}$ or less. Green finely rayed with dark green lines.
30. *Unio irrorata*, *Lea.*
L. 2, H. 2. Pustules on lines of growth. Light green, finely mottled with dark green points.
31. *Unio lacrymosa*, *Lea.*
L. 3 or more, H. $2\frac{1}{2}$ or more. Pustules like tear drops, color green. Variety *Unio asperrima*, *Lea.*, has the pustules more erect.
32. *Unio lens*, *Lea.*
Thick variety of No. 8.
33. *Unio luteola*, *Lam.*
L. $4\frac{1}{2}$ or more, H. $2\frac{1}{4}$ or more. Yellow beautifully rayed with green.
34. *Unio metanevra*, *Raf.*
L. 2 or more, H. 2 or more. Like No. 31 but has no sulcus, posterior ridge has large nodules.
35. *Unio multiplicata*, *Lea.*
L. $4\frac{1}{2}$ or less, H. 3 or less. Posterior rectangular and very much wringled.
36. *Unio multiradiata*, *Lea.*
L. $2\frac{3}{4}$, H. 2. Ventricose and beautifully rayed with green.
37. *Unio obliqua*, *Lam.*
L. $2\frac{3}{4}$, H. $2\frac{1}{2}$. Oblique, brown, faint rays below beaks.
38. *Unio occidens*, *Lea.*
Female of No. 58, shorter and more ventricose.

39. *Unio ovata*, Say.
L. 4, H. 3. Like No. 48, but abruptly flattened posteriorly on each side of hinge.
40. *Unio parva*, Barn.
L. $1\frac{1}{4}$, H. $\frac{3}{4}$. Dull gray,
41. *Unio perplexa*, Lea.
L. $2\frac{1}{2}$, H. $1\frac{3}{4}$. Like No. 22 but irregularly noded—on anterior side of sulcus. Female broader and flatter and rounder on posterior part.
42. *Unio personata*, Say.
L. $1\frac{1}{2}$, H. $1\frac{1}{2}$ or more. Shell thick, slight sulcus, finely rayed with dark green lines.
43. *Unio phaseola*, Hild.
L. $3\frac{1}{4}$, H. $1\frac{3}{4}$. Compressed. Yellow. Interrupted rays of blue.
44. *Unio pilea*, Lea.
Male of No. 42.
45. *Unio plena*, Lea.
L. 2, H. 2. Like No. 37 but higher and thicker through the beaks, nacre pink.
46. *Unio plicata*, Lea.
L. $3\frac{1}{2}$, H. $2\frac{3}{4}$. Like No. 35 but very slightly plicate.
47. *Unio pustulata*, Lea.
Like No. 48 only two rows of pustules.
48. *Unia pustulosa*, Lea.
Like No. 17 but fewer pustules and irregularly grouped nearer the lower margin.
49. *Unio pyramidata*, Lea.
L. $2\frac{3}{4}$, H. 4. Like No. 45 but grows much larger.
50. *Unio rangiana*, Lea.
L. $2\frac{1}{8}$, H. $1\frac{1}{2}$. Like No. 41 but sulcus and surface of shell smoother.
51. *Unio recta*, Lam.
L. 5 or more, H. 1 7-8. Black, faintly rayed; nacre sometimes partly purple.

52. *Unio retusa*, *Lam.*
L. $1\frac{1}{2}$, H. $1\frac{3}{4}$. Nacre white on margin but dark purple within.
53. *Unio ridibunda*, *Say.*
L. $1\frac{1}{4}$, H. $1\frac{1}{8}$. Male of No. 60. Has a double row of teeth projecting from lower posterior margin.
54. *Unio rubiginosa*, *Lea.*
L. $2\frac{1}{2}$, H. 2. Like No. 63 but more compressed. Nacre generally a light salmon color.
55. *Unio sayii*, *Tappan.*
L. $3\frac{1}{2}$, H. $1\frac{3}{4}$. Dirty straw color.
56. *Unio securis*, *Lea.*
Compressed, yellowish green, peculiarly rayed with interrupted light and dark spots. Female thicker.
57. *Unio solida*, *Lea.*
Heavy var. of No. 37.
58. *Unio sub-ovata*, *Lea.*
L. $4\frac{3}{4}$, H. $3\frac{1}{4}$. Ventricose rayed with green on posterior.
59. *Unio sub-rotunda*, *Lea.*
L. $1\frac{1}{2}$, H. $1\frac{1}{2}$. Interrupted dark rays near beaks disappearing in old specimens. Male more elliptical.
60. *Unio sulcata*, *Lea.*
Female of No. 53. Resembles female of No. 50 but the shell is thicker and more globose.
61. *Unio tenuissima*, *Lea.*
L. $3\frac{1}{6}$, H. $1\frac{5}{8}$. Compressed, thin, green, rayed with darker green stripes.
62. *Unio triangularis*, *Barn.*
L. $1\frac{1}{2}$, H. 1. Very triangular, ventricose beautifully rayed with interrupted green stripes.
63. *Unio trigona*, *Lea.*
Sometimes like No. 37, but has no rays and very slight sulcus.
64. *Unio tuberculata*, *Barn.*
L. $2\frac{1}{2}$, H. $1\frac{1}{4}$. Entire surface covered with tubercles.
65. *Unio undulata*, *Barn.*
Variety of No. 46, but has more ridges or plications.

66. *Unio varicosa*, *Barn.*
L. 4, H. $2\frac{3}{8}$, Very close to No. 6 but longer and grows larger.
67. *Unio verrucosa*, *Barn.*
Compressed variety of No. 28.

SUB-GENUS, MARGARITANA.

Teeth defective, especially the lateral.

68. *Margaritana complanata*, *Barn.*
L. $6\frac{1}{2}$, H. $4\frac{1}{2}$. Compressed, resembles No. 1 but nacre white.
69. *Margaritana confragosa*, *Say.*
L. 3, H. $2\frac{3}{8}$. Rough on beaks, undulate on posterior.
70. *Margaritana dehiscens*, *Say.*
L. $2\frac{3}{4}$, H. $1\frac{1}{4}$. Rayed with dark green.
71. *Margaritana deltoidea*, *Lea.*
L. $1\frac{1}{2}$, H. 1. Rayed with green stripes, wrinkled on beaks.
72. *Margaritana marginata*, *Lea.*
L. $3\frac{1}{2}$, H. 2. Shape of No. 62, wrinkled on beaks.
73. *Margaritana monodonta*, *Say.*
L. 4, H. $1\frac{1}{2}$. Black, with one prominent tooth in right valve
74. *Margaritana rugosa*, *Lea.*
L. $3\frac{3}{4}$, H. 2. Compressed, wrinkled on posterior.

SUB-GENUS, ANODONTA.

No teeth.

75. *Anodonta plana*, *Lea.*
L. $4\frac{3}{4}$, H. 3. Ventricose, green, beautifully rayed.
76. *Anodonta decora*, *Lea.* Young of No. 75.
77. *Anodonta edentula* *Lea.*
L. 3, H. $1\frac{3}{4}$. Dark, abrupt on posterior. Shell heaviest of anodonta group.
78. *Anodonta ferussaciana*, *Lea.*
L. $2\frac{3}{4}$, H. $1\frac{3}{8}$. Cylindrical, beaks prominent.
79. *Anodonta imbecillis*, *Say.*
Like No. 78, but beaks very minute.

80. *Anodonta pavonia*, *Lea*.

Like No. 77, but shell thinner.

81. *Anodonta salmonia*, *Lea*.

Like No. 80, but nacre salmon color.

82. *Anodonta wardiana*, *Lea*.

Like No. 78, but not so cylindrical.

FAMILY CORBICULIDÆ.

83. *Pisidium abditum*, *Hald*.L. $\frac{1}{8}$, H. $\frac{1}{8}$. Small and very oblique.84. *Sphaerium occidentale*, *Prime*.L. 5-16, H. $\frac{1}{4}$. Globose, reddish brown, edge white, surface glassy.85. *Sphaerium partumeium*, *Say*.

Like No. 84, thin, frail and more compressed.

86. *Sphaerium rhomboideum*, *Say*.

Like No. 85, but more rhombic.

87. *Sphaerium simile*, *Say*.

Not quite as rhomboidal as No. 86.

88. *Sphaerium solidulum*, *Prime*.

More ventricose and shell thicker than No. 89.

89. *Sphaerium stamineum*, *Conr*.

Sub-triangular, lines of growth well developed.

90. *Sphaerium striatinum*, *Lea*.

Quite common, dark brown, parallel ridges on beaks.

91. *Sphaerium transversum*, *Lam*.

Like No. 85, but longer.

ABBREVIATIONS, SIGNS, ETC.

H.—Height.

W.—Width.

L.—Length.

Figures following any of the above represent inches or fractions thereof.

Figure following the names are the numbers of species which are very similar.

CATALOGUE OF THE ODONATA OF OHIO.

PART II.

By D. S. KELLICOTT, Columbus.

The first part of this Catalogue was published last year,* and contained very few references to localities south of Columbus. At the time of the former publication it was the intention to more thoroughly explore the southern portions of the state and publish a second part at no distant day. During the summer of 1895, much collecting was done in different parts of the state, more especially from Columbus south, and along the Muskingum and Ohio rivers. The result has been a good number of additions to the list and the extension of the known localities for many species already recorded. A record of these facts is the main purpose of this communication. The species added are numbered after those of Part I, in the order they would fall in the systematic arrangement adopted. At the end of the paper is appended a summary of the distribution and the time of occurrence of all our known species.

(2.) AGRIONINÆ.

69.—LESTES CONGENER Hagen.

It was not uncommon along a mere thread of water in the "Old-river-bed" on the State University grounds, Columbus, throughout September, 1895. Not seen elsewhere. It was not seen after the first days of October, but was clearly the last species of its genus abroad.

70.—ERYTHROMMA CONDITUM Hagen.

Two males and two females were taken by B. M. Rutan, May 22, along a ditch of spring water on the Campus of the State University, Columbus; two males and a female were captured by the writer at Greenwood Lake, Delaware, May 30, 1895: Yellow Springs, (W. J. Hancock.)

71.—ENALLAGMA CARUNCULATUM Morse.

Cincinnati, July 19; Columbus, July to September 26; Sandusky, August 15, 1895. It has been taken in every part of the state. At

*Jour. Cin. Soc. Nat. Hist., vol. XVII, Jan'y, 1895, p. 195.

Cincinnati on the given date *civile* and *carunculatum* were flying together by the Miami Canal and Ross Lake; *civile* greatly predominating. July 22, at Grand Reservoir the former were few and *carunculatum* were in extreme abundance; the same relation as to proportion existed further north at Grand Rapids and Toledo.

The remarks made under *E. civile* (19) in the first part must apply in part to this species, for I find both species under one label in the collection.

72.—*ENALLAGMA HAGENI* Walsh.

Four males captured by Arthur S. Hill, near a deep pool at Waynesburg, in June, 1895. Mr. Hill says they were common in this locality, but were not seen elsewhere.

73.—*ENALLAGMA DIVAGANS* Selys.*

One pair taken by E. E. Bogue, at Orwell, June, 1895.

74. *ANOMALAGRION HASTATUM* Say.

Three males were taken by Seth Hayes at Ross Lake, Cincinnati, July 18, 1895; the following day the writer captured five males among the weeds of a drained "ice pond" near the former locality.

(3.) GOMPHINÆ.

75.—*GOMPHUS DILATATUS* Rambr.

One male taken by A. H. Dunham in May, 1895, at South Columbus.

After considerable perplexity and a degree of temptation I have referred this single perfect specimen as above. First of all, it has *all the triangles once crossed* and the metathoracic femora reach fully to the

*In Part I, No. 21, I referred at some length to the habits and distribution of a species which I had mistaken for *E. divagans* Selys. I have since concluded that it was an undescribed species and I have given it a name, *E. geminata*, in *Entomological News*, vol. VI, p. 239. All that is said in the paper cited as referring to *divagans* applies to *geminata*.

During the summer of 1895, I have taken it as follows: May 25, several of both sexes at Reservoir Park; May 30, Delaware; July 14, exceedingly abundant at Licking Reservoir; July 30, not uncommon at Corunna, Michigan; August 24, Parish, N. Y.

I have one unique male taken at Corunna; it has a double, blue spot on the seventh abdominal ring, similar to, although smaller than, the corresponding marks of the female.

middle of the second abdominal ring; in fact, so far as the head, thorax, wings and length of femora are concerned, it might, with propriety, be referred to *Hagenius*; on the other hand the dilatation of 7, 8 and 9, as well as the form of the anal appendages are strictly in accord with *Gomphus*. The abdomen measures 50 mm. and the hind wing 40 mm. Comparison with Hagen's and Selys' descriptions of *dilatatus* discloses very close agreement except, of course, the crossed triangles. There are slight variations, however, for example, the lateral expansion of 8 has the anterior half yellow and there is a small tooth beneath, at the beginning of the oblique truncation of the superior appendages. (This is not mentioned in the descriptions); the dorsal band includes 7; the membranule is white and the pterostigma yellow. More material will be earnestly sought for when May returns.

76.—*GOMPHUS EXTERNUS* Selys.

One male captured—others seen—at Sugar Grove, May 18, 1895.

The male has a peculiarity of flight which I do not remember to have seen in any other Gomphid. Those observed were resting along a sunny, sheltered roadway and when disturbed they would fly back and forth, rising and falling in curves after the manner of a May-fly in its love-flight.

77.—*GOMPHUS FRATERNUS* Say, var. *WALSHII*.

I have taken, in May and June along the Olentangy river at Delaware and Columbus, several examples of *Gomphus*, which I am led to think represent the form or variety of *fraternus* which Mr. B. D. Walsh referred to in his accurate notes on this species,* and which he said varied from the usual form by a yellow vitta on 9. The variety, as I think it may with propriety be regarded, is easily separated from the normal type by differences as follows: 1—The wide yellow vitta on 9 referred to by Walsh; 2—The males of the variety are larger: the length of abdomen (average of several) is 40 mm. and hind wing 31 mm. in the variety; in the other the same parts are 37 mm. and 29 mm. respectively; 3—The occiput of the variety is straight or even a little concave in some, while in *fraternus* it is decidedly convex; the tenth ring has a dorsal, mesal yellow line; there is a small tubercle near the tip of the superior anal appendages

*Proceedings Ent. Soc. of Phila., vol., II, 240.

of both forms, but it stands nearer the outer edge in *Walshii* and there is a plain sinus just cephalad of the tubercle—seen best at an angle from above; this is wanting in *fraternus*, and the superior appendages are slenderer, at least apically, in the variety.

I have not found the two forms flying together, but this must be accidental for both are abroad at the same season and have similar habits, that is, they fly about the swiftest and most turbulent parts of the river. I have taken many examples of *fraternus* at Sandusky and McConnellsville, but the variety only as stated above.

78.—GOMPHUS FURCIFER Hagen.

Three males were taken at Reservoir Park, June 14, 1895. They were found resting on floating leaves of *Nelumbium luteum*. In manners and appearance it closely agrees with *villosipes* although readily separated by differences in anal appendages and by the occipital tubercle, present in *villosipes* absent in *furcifer*.

(4.) CORDULEGASTERINÆ.

79.—CORDULEGASTER OBLIQUUS Say.

One male was taken by E. E. Bogue, at Orwell, in June, 1895.

(5.) ÆSCHNINÆ.

80.—GOMPHÆSCHNA FURCILLATA Say, var. ANTILOPE Hagen.

One male taken at Columbus, June 13, 1895.

Others were seen from time to time flying about the orchard and garden of the University farm, especially over the glass roofs of the green-houses.

(6.) CORDULINÆ.

81.—DIDYMOPS TRANSVERSA Say.

Five males, Sugar Grove, May 18, 1895; one male, Columbus, June, 1895.

The males fly along the borders of the larger streams in a manner quite similar to *Macromia* and are more easily taken. At Sugar Grove several pairs were seen at rest on foliage, often near the ground, along a wagon-road near a small river.

82.—TETRAGONEURIA SEMIAQUEA Burm.

One male was taken near Columbus, in May, by A. H. Dunham. Several individuals were seen by the writer at Greenwood Lake, Delaware, May 25, 1895.

(7.) LIBELLULIDÆ.

83.—PANTALA HYMENÆA Say.

One male taken while flying about a receding puddle in a gravel-pit, Cincinnati, July 18, 1895.

84.—LIBELLULA AXILLENA West. form. VIBRANS Fab.

Columbus, June 8; Licking Reservoir, June 14, 1895. It appears to spend less time on the wing than any other species of *Libellula* in our list.

85.—DIPLAX CORRUPTA Hagen.

Two males and two females were taken at Ross Lake, Cincinnati, July 19; one male at Port Clinton, August 15, 1895. It thus appears to occur throughout the "maritime" parts of Ohio and in one locality at least it is not rare.

86.—DIPLAX MADIDA Hagen (?)

Three males were taken on the shore of Lake Erie, at Port Clinton, August 15, 1895.

This species appears to be more at home "out at sea" than any other one of its genus that I have observed. The males were found sporting about and over wide shallow pools of the sandy beach; the females were seen several times to fly from repose far out over the waves, touching a crest now and then and finally returning; unfortunately none were captured.

While the species agrees in many ways with Dr. Hagen's description in "Psyche" V, 385, there are also disagreements, as I understand his diagnosis, so I have grave doubts as to the correctness of the reference. The size is that of *madida*; the wings are not flavescent at base and on the costa; they are hyaline throughout, at least in my specimens which are old; but the veins are reddish brown; the hamuli are not yellow but dark brown; in form, on the other hand, they appear to agree, the thick, ovate outer lobe bears a stout hook on

its inner margin and remote from the apex; the genital lobe and the anal appendages agree. There is an extra transverse carina on 4, which Dr. Hagen has not mentioned as present in *madida*.

NOTES ON CERTAIN SPECIES REFERRED TO IN PART I.

1. *Lestes inequalis* was taken by Mr. E. E. Bogue, June, 1895, at Orwell, and by the writer at Reservoir Park in June. It probably occurs throughout the northern part of the state.

L. vigilax has been taken the past season over about the same range.

2. *Argia putrida* ranks with *Anax junius* and *Ischnura verticalis* in season range, viz:—from May to October. At Lakeside it was observed flying and pairing during a rainy afternoon. The following observations were made the same day on its habit of ovipositing under water. Four pairs were noted on a timber of the dock; they were from barely covered to six inches under water; the following notes were made at the time.

PAIR 1. ♂ abandoned ♀, emerged and flew away after five minutes, ♀ remained one hour.

PAIR 2. ♂ abandoned ♀ in seven minutes, ♀ remained fifty-five minutes; after exposure to the air for a short time she returned beneath the water for fifteen minutes.

PAIR 3. ♂ remained submerged twenty minutes, ♀ thirty; she flashed her wings and immediately returned for twenty five minutes.

PAIR 4. They were disturbed, emerged and flew away together.

PAIR 5. They were seen to alight on the dock just above the water and slowly back down until they were covered.

3. *Nehalennia irene* has been taken the past summer at Columbus, June 5, and at Springfield, July 6; in every case taken by reed-grown ponds or streams fed by clear spring water. *N. gracilis* recently described by A. P. Morse and hitherto confounded with *irene* does not appear among numerous examples from different parts of Ohio and Michigan.

4. *Enallagma Fischeri* was taken at Georgesville, June 26, Bucyrus, June 28, Springfield, July 6; one male was seen in the collection of Cornell University presumably captured at Ithaca.

Under No. 71, *E. carunculatum*, the extreme abundance at Grand Reservoir was mentioned, singularly no other species, except perhaps, *Perithemis domitia* was at all common. In one instance a chain of

three *E. carunculatum* was seen flying about; it is needless to say two were males.

5. There are now fourteen Gomphines listed for Ohio. I feel confident that several more regional species remain to be detected within our limits.

The following remarks are made as suggestions to collectors: *Hagenius brevitsylus* flies through July and the greater part of August. (This year taken August 24, Parish, N. Y.); it is found about larger streams; *Gomphus spiniceps* in August and September about smaller swift flowing brooks. All the remaining species occur from May to July 15. *Gomphus fraternus*, *fraternus* var. *Walshii*, *vastus* and *spicatus* frequent the borders of wave-beaten shores or rushing rivers; the males, during the warm sunny hours, make frequent excursions over the crested waves after each of which they return to shore for rest; the females generally remain in the herbage or higher on trees near by, flying out occasionally to deposit their eggs in the disturbed waters and often bringing back a consort to the place of rest. *Gomphus villosipes*, *exilis* and *furcifer* frequent quiet waters of smaller ponds, or even ditches where there are floating algæ or lily pads on which to rest. The males explore the borders and watch from the muddy shore or floating plants; the females at intervals drop down from their coverts to oviposit among the plants dipping into the water in a manner similar to that of *Libellula*. The habits of *G. graslinellus externus* and *dilatatus* I have not observed.

Both our species of *Dromogomphus* prefer larger strong flowing streams and fly in northern Ohio during July.

Additional localities for species enumerated in the first paper are these; *fraternus*, McConnellsville, June 18, *villosipes*, Delaware, May 30, Columbus, June 8-13; *exilis*, Sugar Grove, May 18, Delaware, May 30; *spicatus*, Sandy Beach, July 1, where it was very abundant among the reeds off the shallows; *D. spinosus*, Bucyrus, June 28.

6. *Fonscolombia vinosa* can no longer be considered rare or local in Ohio. I found it quite numerous at Georgesville, September 4, and it was seen at Blendon, September 14. At Parish, Oswego Co., N. Y., the latter part of August, it was really abundant and afforded an excellent opportunity for noting its habits. It prefers seclusion, hence should be looked for along ponds and streams with well wooded banks, where branches overhang the water and where half submerged logs and rubbish abound. The males may be seen from early in the

forenoon until dark of warm days, exploring every corner among the obstructions at the water's edge; an interesting habit noted was that it would often fly out and carefully examine a passing skiff. The females when not ovipositing are suspended from some over-hanging twig.

7. *Basiaeschna janata* was not uncommon at Columbus, May 1.

8. *Macromia illinoiensis* was common along the Muskingum, June 18.

9. *Tetragoneuria cynosura* sparingly present at Sugar Grove, May 18, was in great numbers at Reservoir Park, May 25, and at Delaware, May 30; by June 15, its time had passed, when only a rare and worn example was to be found.

10. *Pantala flavescens*. Six males and five females were captured at Port Clinton, August 15. They were resting in the herbage bordering the lake shore; September 28, several were met with flying by the canal at South Columbus.

11. *Tramea lacerata* was common at Reservoir Park, June 14, and at Cincinnati and Franklin, July 11-19.

12. *Libellula semifasciata* was abroad at Columbus, April 28; it was the first of its genus to take wings.

13. The species of *Diplax* which was with doubt referred to *costifera* (No. 62) I find is not that species. Its wings and size agree but the male appendages do not. No additional examples have been taken.

Eighty-six species and varieties have been enumerated in this catalogue. All but one, are represented by one or more specimens in the collection of the Ohio State University. More or less collecting has now been done in every quarter of the state, still there are several promising fields not yet adequately explored; notably north-eastern Ohio and especially about the lakes of Summit County. In view of this and after carefully considering the local lists, not forgetting the fact that two species not hitherto recognized in the state have been found this past summer within five minutes walk of my department chair in the University, I am convinced that it is not unreasonable to estimate the number of Odonates at present inhabiting Ohio at one hundred.

It is the intention to continue to search and to print from time to time additions to the catalogue as new studies are completed and more species are taken until the habits, histories and distribution of our Dragon-flies are much better known than at present.

The following table has been prepared to show at a glance approximately the distribution over the state and the time of flight, in accordance with our present knowledge, of the previously mentioned species :

No.	NAME	North O.	Cent. O.	South O.	Early Sum.	Mid. Sum.	Late Sum.
1	C. maculata.....	x	x	x	x	xx	x
2	C. æquabilis.....	x	x			x	
3	H. americana.....	x	x	x		x	xx
69	L. congener.....		x				x
4	L. unguiculata.....	x	x			x	
5	L. uncata.....	x				x	
6	L. disjuncta.....	x	x			x	
7	L. forcipata.....	x				x	
8	L. rectangularis.....	x	x	x	x	x	x
9	L. vigilax.....	x	x			x	
10	L. inequalis.....	x	x			x	
11	A. putrida.....	x	x	x	x	x	x
12	A. violacea.....	x	x	x	x	x	
13	A. tibialis.....		x	x	x	x	
14	A. apicalis.....	x	x	x		x	x
15	A. sedula.....		x	x		x	x
70	E. conditum.....		x		x		
16	N. irene.....	x	x	x	x	x	
17	N. posita.....	x	x	x	x	x	x
18	A. saucium.....	x	x	x	x	x	
19	E. civile.....	x	x	x	x	x	x
71	E. carunculatum.....		x	x		x	
20	E. ebrium.....	x			x		
21	E. geminata.....	x	x	x	x	x	x
73	E. divagans.....	x			x		
22	E. exsulans.....	x	x	x	x	x	x
72	E. hageni.....	x			x		
23	E. signatum.....	x	x	x	x	x	x
24	E. pollutum.....	x	x			x	
25	E. Fischeri.....	x	x	x	x	x	
74	A. hastatum.....			x		x	
26	Is. verticalis.....	x	x	x	x	x	x
27	H. brevistylus.....	x	x			x	x
75	G. dilatatus.....		x		x		
28	G. vastus.....	x			x		
29	G. graslinellus.....		x		x		
30	G. fraternus.....	x	x	x	x		
77	G. " var. Walshii..		x		x		
76	G. externus.....		x		x		
31	G. villosipes.....	x	x		x		
78	G. furcifer.....		x		x		
32	G. spicatus.....	x			x		
33	G. exilis.....		x		x		

No.	NAME	North O.	Cent. O.	South O.	Early Sum.	Mid. Sum.	Late Sum
34	G. spiniceps		x				x
35	D. spinosus	x	x		x	x	
36	D. spoliatus	x				x	
37	C. erroneus		x			x	
79	C. obliquus	x			x		
38	E. heros	x	x	x	x	x	
39	F. vinosa	x	x				x
80	G. antilope		x		x		
40	B. janata		x		x		
41	Æ. verticalis		x				x
42	Æ. clepsydra	x					x
43	Æ. constricta	x	x	x			x
44	A. junius	x	x	x	x	x	x
81	D. transversa		x		x		
45	M. tæniolata	x				x	
46	M. illinoiensis	x	x	x		x	
47	E. princeps	x	x	x	x	x	x
48	T. cynosura		x		x		
82	T. semiaquea		x		x		
49	P. flavescens	x	x				x
83	P. hymenæa			x		x	
50	T. carolina		x		x	x	x
51	T. lacerata	x	x	x	x	x	x
52	L. basalis	x	x	x	x	x	x
53	L. auripennis		x		x		
54	L. quadri-maculata		x		x		
55	L. semifasciata		x	x			
56	L. pulchella	x	x	x	x	x	x
84	L. vibrans		x		x	x	
57	P. tri-maculata	x	x	x	x	x	x
58	C. eponina	x	x	x	x	xx	x
59	L. intacta	x	x	x	x	x	
60	D. rubicundula	x	x	x	x	x	x
61	D. assimilata	x	x			x	x
62	D. ———		x				x
63	D. obtrusa	x	x	x		x	x
64	D. semicincta	x	x	x	x	x	
65	D. vicina	x	x	x		x	xx
85	D. corrupta	x		x		x	x
86	D. madida (?)			x		x	
66	P. domitia	x	x	x	x	x	
67	M. simplicicollis	x	x	x	x	x	x
68	P. longipennis	x	x	x	x	x	x

MANUAL OF THE PALEONTOLOGY OF THE
CINCINNATI GROUP.

BY JOSEPH F. JAMES, M. D., M. Sc., F. G. S. A., ETC.

PART VII.

(Continued from p. 88.)

Monticuliporoidea (concluded).—*Echinodermata*.

MONTICULIPORA.

SUB-GENUS A.

DEKAYIA Edw. & Haime, 1851.

Corallum branching, with corallites of two kinds, the larger ones polygonal with thin walls and with well developed tabulæ; smaller tubes with thickened walls, isolated by the larger ones, and appearing at the surface as so many detached, blunt, spine-like processes, placed at the angles of junction of larger tubes. (Pol. Foss. des Terr. Pal. 1851, p. 277. Nicholson, Pal. Tab. Corals, 1879, p. 291.) (*Dekayella* Ulrich, Jour. Cin. Soc. Nat. Hist. vol. 5, 1882, p. 155.)

Remarks.—This sub-genus can only be separated from *Monticulipora* proper by the surface columns, which constitute a marked feature of the exterior. Mr. Ulrich's *Dekayella* can not be regarded as distinct. In his latest publication (Pal. of Minnesota, vol. 3 of Geol. and Nat. Hist. Survey, 1893, p. 269) he gives in substance the following description: Corallum ramose; branches cylindrical or compressed; calices angular or rounded, their shape depending upon the number and disposition of the interstitial corallites; these are more or less numerous distributed among the larger calices and aggregated into irregular clusters, or they may be wanting except in the clusters or even absent nearly altogether; spiniform tubuli of all sizes, the larger ones commencing in the axial region, the smaller ones more abundant and developed in the peripheral region only; tabulæ horizontal, numerous.

In his remarks upon the genus Mr. Ulrich states that it might be well to unite *Dekayia*, *Dekayella* and *Heterotrypa* (as restricted by him) into one, for the reason that there are so many intermediate forms. He eventually concludes, however, to keep them distinct.

Quite a number of species have been described from our group, but they do not seem to be founded upon very good characters. Those that seem worthy of specific rank are given below.

78.—M. (DEKAYIA) ASPERA. Edw. & Haime, 1851.

Corallum dendroid, branching frequently and dichotomously and arising from a broad basal expansion; branches varying from two to eight lines in diameter according as they are near the top or at the base of the corallum; surface usually with low and rounded monticules, four or five in about one-half inch; formed of cells very little larger than the average and often with a limited number of smaller interstitial cells; spines conspicuous with thick walls and small cavity occupying angles of cells; corallites polygonal; tabulæ wanting in the axial region and remote in the peripheral. (Pol. Foss. des Terr. Pal., 1851, p. 277. Ulrich, Jour. Cin. Soc. Nat. Hist., vol. 6, 1883, p. 149.) (*Chætetes attritus* Nich., Quar. Jour. Geol. Soc. Lond., vol. 30, 1874, p. 503: *Dekayia multispinosa* Ulrich, Ibidem, p. 154.)

Locality.—Cincinnati.

Remarks.—In a previous paper several other synonyms were given for this species.* While the species is a variable one it has been deemed best in the present instance to increase the number of species, perhaps unwisely. All seem to agree that Nicholson's *attrita* is the same as *D. aspera*, and *D. multispinosa* differs mainly in a larger number of surface spines. Internally the structure of the two is the same.

79.—M. (DEKAYIA) MACULATA James, 1881.

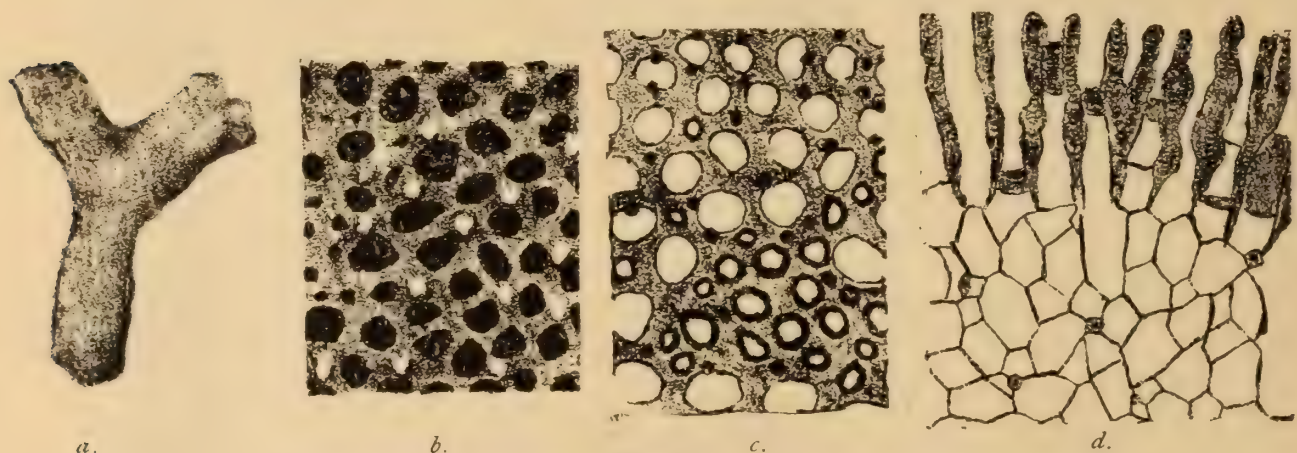


Fig. 11.

Fig. 11.—M. (*Dekayia*) *maculata* James: *a*, specimen nat. size; *b*, surface x 18; *c*, tangential section, x 18; *d*, longitudinal section, x 18. (After an unpublished plate by Ulrich.)

* Jour. Cin. Soc. Nat. Hist., vol. I, 1888, p. 28.

Corallum dendroid, branches cylindrical or sub-cylindrical two to four or more lines in diameter, branching dichotomously; surface with conspicuous, rounded elevations or monticules, occupied by cells much smaller than the average; calices irregular in form, circular or polygonal, varying in size; interstitial tubes occasionally present; spines, at angles of the cells, conspicuous: walls of corallites thin, internal structure unknown. (The Paleontologist, No. 5, June, 1881, p. 36.)

Locality.—Loveland, O.

Remarks.—This form seems mainly distinguishable by the groups of cells smaller than the average. Although previously placed as one of the synonyms of the preceeding, it seems to possess characters sufficient to permit its being considered a distinct species.

80. —M. (DEKAYIA) PELLICULATA Ulrich, 1883.

Corallum dendroid, with smooth, thick, rounded or flattened branches, arising from a broad base, varying in diameter from three lines to one inch; surface smooth but often with clusters of cells slightly larger than the average, with small aggregations of much smaller cells; surface also frequently covered with a thin pellicle; spines prominent; calices angular; corallites with very thin walls in the axial region, which become thickened toward the surface; tabulæ few in the axial region but more numerous in the peripheral. (Jour. Cin. Soc. Nat. Hist., vol. 6, 1883, p. 150.) (*Dekayia appressa* Ulr. Ibid, p. 152; *D. paupera* Ulr. Ibid, p. 153.)

Locality.—Cincinnati.

Remarks.—There does not seem to be any good characters by which the forms described as *appressa* and *paupera* can be separated from *pelliculata*. They are more varietal than specific.

SUB-GENUS B.

CONSTELLARIA Dana, 1846.

Corallum dendroid or incrusting, with the branches cylindrical, flattened, or more or less frondose; surface with more or less conspicuous star-shaped, depressed maculæ made up of small tubes surrounded by a variable number of (8 to 20) ridges, radiating outward and carrying large tubes; occasionally nearly smooth; calices oval or circular, with thick walls; corallites of two kinds, the larger circular or oval, with well developed walls which are thickened as the surface is

approached; tabulæ few and chiefly developed in the outer portions; small corallites developed at the angles of junction of the larger ones, especially in the depressed centres of closely disposed stellate areas which project above the surface as star-shaped elevations; walls of the small corallites imperfectly developed; these corallites angular or sub-angular, with numerous tabulæ which are sometimes sub-vesicular. (Explor. Exped., Zoophytes, 1846, p. 537. Nicholson, Pal. Tab. Corals, 1879, pp. 292, 300; Ibid., Genus Montic., 1881, p. 97.) (*Stellipora* Hall, Pal. of New York, vol. 1, 1847, p. 79.)

81.—M. (CONSTELLARIA) POLYSTOMELLA Nicholson, 1875.

Corallum forming palmate or sub-lobate, flattened expansions, or cylindrical stems, varying in height and thickness: generally from one and one-half lines to two lines thick, and composed of corallites radiating from an imaginary central plane in all directions to the surface; the surface with numerous stellate areas, one line apart, consisting of a depressed central space, surrounded by from six to fourteen or more prominent and radiating ridges; corallites of two kinds: the larger oval or circular, occupying the general surface of the corallum, and found especially on the ridges of the star-shaped monticules: smaller ones occupying inter-spaces between the larger ones, and especially the central depressed areas; tubes thin-walled; tabulæ complete and horizontal, few or absent in the axial regions, but increasing in number toward the peripheral region, and at the surface crowded close together. (Pal. of Ohio, vol. 2, 1875, p. 215.) *Constellaria antheloidea* Nich. Ibid, p. 214 *non* Hall; *C. florida* Ulrich, Jour. Cin. Soc. Nat. Hist., vol. 6, 1883, p. 267: *C. limitaris* Ulr. Ibid, p. 269: *C. fischeri* Ulr. Ibid, p. 270: *Stellipora limitaris* Ulr. Ibid, vol. 2, 1879, p. 126.)

Locality.—Cincinnati and numerous places in the vicinity; Mt. Sterling, Ky., Tennessee, Canada, Wisconsin, etc.

Remarks.—This is a variable and wide-spread species, ranging from the Trenton through the whole of the Cincinnati group. Various attempts have been made to separate forms as species or varieties, but not, to our belief, with any success. Attention should be called to the fact that the species under consideration has been called *C. antheloidea* Hall. It is an error, since this species is parasitic, while *polystomella* is ramose or frondescent; it is also a Trenton form occurring in New York. It may, however, yet be found in our region.

82.—M. (CONSTELLARIA) PARVA Ulrich, 1890.

Corallum irregularly undulating or frondose, 2 to 3 mm, thick, 25 mm. or more high, from a broad base: surface smooth, with star-shaped maculæ from 1 to 1.5 mm, apart, about 60 in 10 mm. square: walls of corallites thin throughout, ringlike in the mature region, bending rather abruptly from the axial to the peripheral region; about 0.08 mm. in diameter between the stars, the 2 to 6 cells between the rays of the maculæ about 0.13 mm. in diameter: calices circular with a peristome: interstitial cells angular, thin-walled, arranged in star-shaped maculæ, and in the intermediate spaces surrounding the corallites in 1 or 2 series: tabulae from one-half to one tube-diameter apart in the peripheral region, and from 1 to 2 diameters apart in the axial region: very crowded in the interstitial cells. (Geol. Sur. Ills., vol. 8, 1890, p. 425.)

Locality.—Wilmington, Ills.

SUB-GENUS C.

FISTULIPORA McCoy, 1849.

Corallum ramose or incrusting: corallites of two kinds, larger ones oval or circular, with few and remote tabulæ, with well developed walls, not thickened toward the surface; often with oblique calices, surrounded by small, interstitial cells in one or two rows, the apertures generally angular; tabulæ in these corallites numerous, sometimes vesicular, by imperfection of the walls of the neighboring corallites; maculæ, if present, generally made up of smaller cells than the average, never elevated above the surface, or surrounded by radiating ridges as in *Constellaria*; interstitial cells often closed by a thin, calcareous membrane: walls of calices generally thin. (Ann. & Mag. Nat. Hist., 2d ser. vol. 3, 1849, p. 130. Nicholson, Pal. Tab. Corals, 1879, pp. 292, 304.) (*Callopora* Hall, Pal. of N. Y., vol. 2, 1852, p. 144.)

83.—M. (FISTULIPORA) OWENI James, 1884.

Corallum in flat, twisted expansions, one-half to one line thick; sometimes lobate, or in sub-cylindrical, hollow tubes: surface with clusters of eight or ten projecting apertures in each line, sometimes regularly and again irregularly arranged maculæ about one line apart and about one-half a line across; sometimes depressed, the interstitial

spaces occupied by small pores: corallites arising from a delicate, striated epitheca; calices sub-oval or sub-circular: walls thin, but thicker on one side than on the other: tubes slightly curved at the base, then vertical to the surface, sub-oval or sub-circular: obscure horizontal tabulæ, with a few vesicular attachments to the walls. (Jour. Cin. Soc. Nat. Hist., vol. 7, 1884, p. 21.) (*Diamesopora oweni* Ulrich, Geol. Sur. Illinois, vol. 8, 1890, p. 467.)

84.—M. (FISTULIPORA) RUSTICA Ulrich (sp.). 1893.

Corallum irregularly ramose, branches 5 to 10 mm. in diameter: surface with low, rounded eminences, occasionally, rough under a lens: the spini-form corallites numerous but not inflecting the walls of the corallites; apertures or calices rounded, 11 in 3 mm.; interstitial cells abundant, unequal, "rounded at the surface:" tangential sections just below the surface show the corallites to be rounded, with moderately thick walls: interstitial cells sharply defined, sub-angular, unequal, three or four to each corallite: spiniform tubuli strong, two to each corallite: mainly in the walls, which are occasionally bent inward; at a deeper level, the walls are thinner: tabulæ abundant in all of the tubes, mainly horizontal in the axial, but vesicular in the peripheral region. (Pal. of Minn., vol. 3 of Geol. and Nat. Hist. Survey, 1893, p. 234 as *Homotrypella rustica*.)

Locality.—Various places in Ohio, Indiana and Minnesota.

85.—M. (FISTULIPORA) GRANULIFERA (Ulrich) 1879.

Corallum ramose with sub-cylindrical branches, dividing dichotomously at varying distances, sometimes irregularly thickened or nodulated and having a diameter of from two to five lines: surface smooth or with obscure tubercles or maculæ: in the former case composed of tubes slightly larger than the average and in the latter of minute tubuli: calices unequal, varying from circular or oval to sub-polygonal: intercellular spaces thick and with numerous small corallites, in unworn specimens appearing like spines, but in worn examples showing a tubular character: tabulæ few in the axial region but becoming more numerous toward the surface: walls thin. (Jour. Cin. Soc. Nat. Hist., vol. 2, 1879, p. 128 as *Chætetes*: *Homotrypella granulifera* Ulr., 14th Rept. Geol. and Nat. Hist. Sur. of Minn., 1886, p. 83.)

Locality.—Frankfort, Bergen, etc., Kentucky.

Remarks.—This was in the paper on Monticuliporoids placed as a synonym of *M. (F.) venusta*, but further consideration indicates that this is more likely a polyzoan than a coral and it will be described under that group.

86.—*M. (FISTULIPORA) NICHOLSONI* James, 1875.

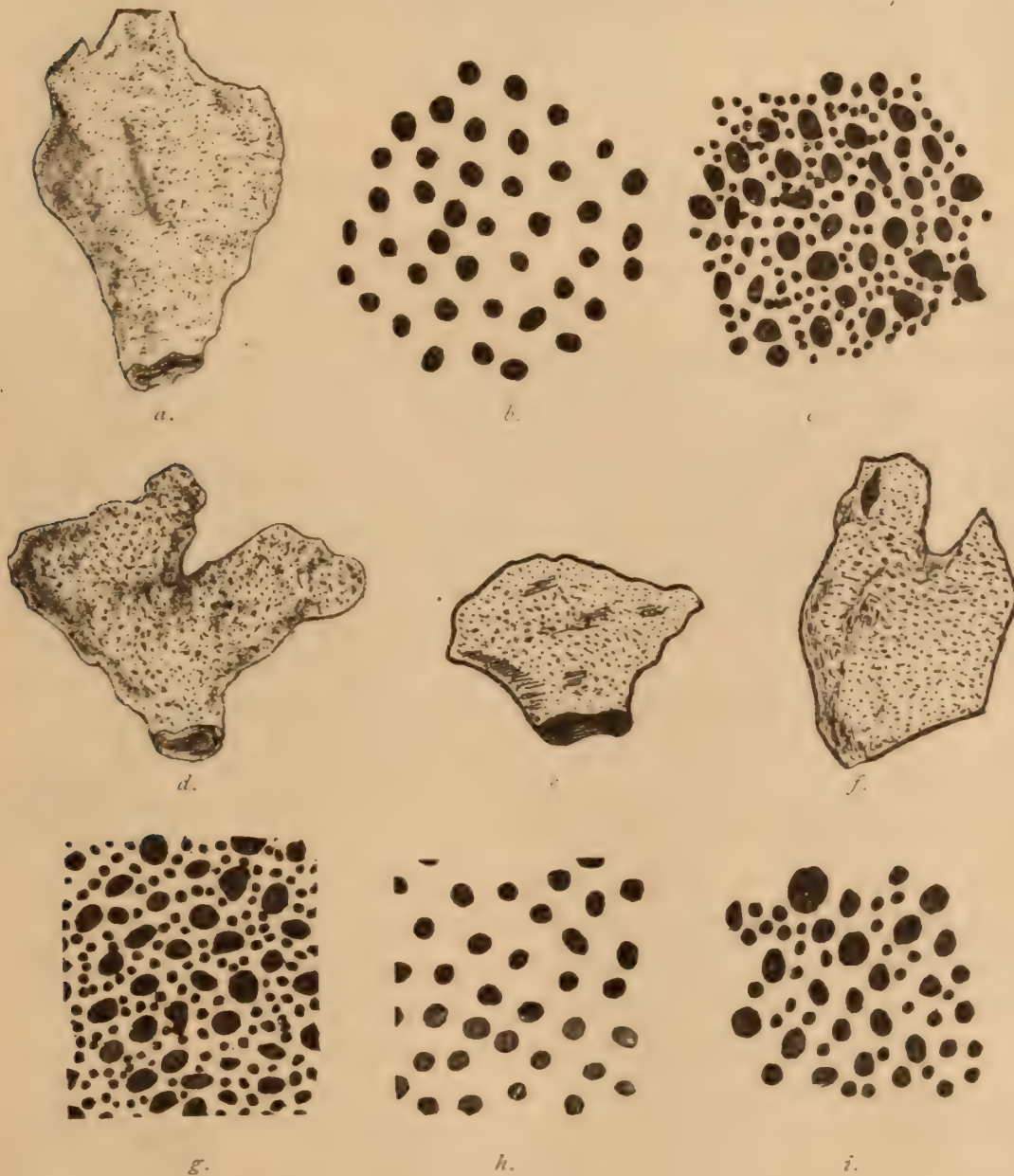


Fig. 12.

Fig. 12 — *M. (Fistulipora) nicholsoni* James: Various figures showing variation: *a, b, c* *M. nicholsoni* (typical) *b* and *c* showing surface features, enlarged but at different points on the same corallum: *d, e, f, g* and *h* views of *F. siluriana* James: *g* and *h* views of surface, enlarged, from different points on same corallum: *i* surface features, enlarged, of corallum described as *F (?) multipora*. (Original.)

Corallum incrusting, or forming more or less branching or frondose masses: surface smooth: calices in perfect specimens slightly oblique, or arched, with raised and very thin margins; in slightly worn specimens calices circular or oval, often with a ring-like margin and surrounded by one or two rows of polygonal interstitial cells: in specimens still more worn the cell apertures have thicker walls and interstitial cells are ill-defined. (Cat. Foss. Cin. Group, 1875, p. 3, as *Ceramopora*.) (*Fistulipora? multipora* James. The Paleont., 1878, p. 2; *F. siluriana* James, Ibid, 1879, p. 19; *F. flabellata* Ulrich, Jour. Cin. Soc. Nat. Hist., vol. 2, 1879, p. 28.)

Locality.—Cincinnati.

Remarks.—The names cited as synonyms above are believed to have been given because of the various aspects a single species presents under different conditions. A single specimen will sometimes show in one position the arched, thin-walled apertures: in another the ring-like, circular aperture with numerous interstitial cells, and in still another place an absence of interstitial cells. It has been mainly upon these features that the above names have been given. What was described as *F. siluriana* was a worn state with thick intercellular spaces: *flabellata* is a less worn condition with numerous interstitial cells: and *multipora* is still less worn with a smaller number of irregularly shaped interstitial cells.

87.—M. (FISTULIPORA) MILFORDENSIS James, 1878.

Corallum incrusting, generally growing on crinoid stems, and $\frac{1}{4}$ to $\frac{1}{2}$ a line thick: surface smooth: calices oval or sub-polygonal, not arranged in any regular order: walls of calices elevated, sometimes in contact with neighboring calices, and sometimes separated: in the latter case the intercellular spaces with many small, irregular calices. (The Paleont., No. 2, Sept., 1878, p. 11 as *Callopora*.)

Locality.—Hamilton and Clermont counties.

Since the first portion of this paper was published the following species has come to light. The description was found among the papers of Mr. U. P. James, and the specimen was in his collection. This is now in the Chicago University. The illustrations were made from the type specimen. It is believed to be sufficiently distinct from all described species to warrant a name.

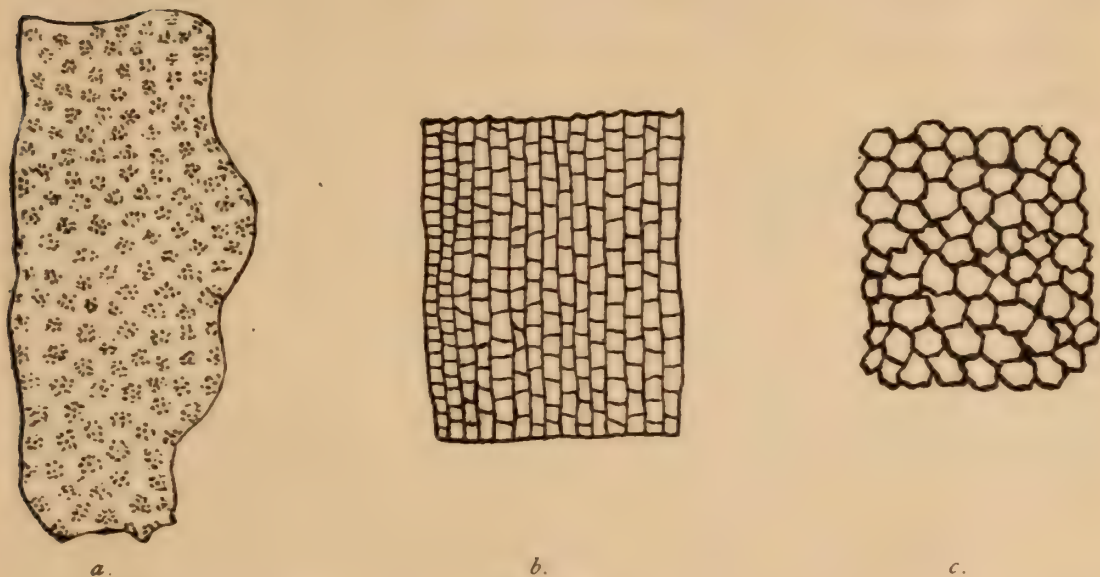
88.—*M. SUBCYLINDRICA* U. P. James, n. sp., (in MS.)

Fig 13.

Fig. 13.—*Monticulipora subcylindrica*, U. P. James, (n. sp., in MS.) *a* type specimen, half nat. size; *b* longitudinal section, magnified; *c* surface, magnified. (Original)

Corallum irregularly sub-cylindrical, about four and one-half inches long, by one to one and one half inches in diameter, tapering gradually to both ends where it rounds off abruptly: surface with distinct monticules irregularly distributed, about one or one and one-half lines apart and extending even over the ends; calices polygonal, eight or ten in one line, those on the monticules slightly larger than the average: tube walls thin and sharp when unworn; no interstitial corallites: corallites radiating from a central point or a central object directly to the surface, with wavy walls: tabulæ numerous, complete and horizontal, apparently as numerous at the centre as at the periphery.

Locality.—Cincinnati and Morrow, Ohio.

Remarks.—This description is drawn up from notes left by Mr. James and from the specimen labeled by him. It seems to be a good species and to be well characterized by its mode of growth, the uniform cells, and the close tabulation. The specimen was named in 1887, apparently at the time it was found, but the description has never before been published.

INCERTA SEDES.

A few species have been described as belonging to this group that are too indefinite to have any place assigned to them,

and a few remarks will here be made relative to them. One species, also here noticed, belongs, perhaps, in Group 1 (*Massive species*) while another, probably referable here, was originally described as a seaweed.

Homotrypa obliqua Ulrich, (Jour. Cin. Soc. Nat. Hist., vol. 5, 1882, p. 243) was described as dendroid with cylindrical or compressed branches; surface with numerous conspicuous monticules, or else smooth: cells polygonal: apertures more or less oblique; tabulae wanting in the axial region, but both straight and vesicular in the peripheral; connecting foramina are shown in tangential sections. This last feature renders this species anomalous and apparently throws it out of the Monticuliporoids. It occurs near Cincinnati.

Petigopora gregaria Ulrich, (Jour. Cin. Soc. Nat. Hist., vol. 6, 1883, p. 155) was described as parasitic, the corallum consisting of patches from one to three lines in diameter and one-fourth of a line thick: a narrow smooth or wrinkled membrane forms the outer margin, which is slightly elevated: surface smooth; apertures equal: no interstitial cells; spiniform corallites inconspicuous; walls thin and flexuous; tabulae apparently wanting. It occurs at Cincinnati.

Monticulipora hospitalis var. *neglecta* James and James, was briefly described in the paper on Monticuliporoids, (Jour. Cin. Soc. Nat. Hist., vol. 11, 1888, p. 27.) In the absence of the type specimen it is impossible to give any other details than those there given. This description is as follows: "Corallum irregularly conical: surface with many prominent monticules about one line apart: calices equal in size, sub-polygonal: corallites take a direct course from base to apex."

A species described by Mr. E. O. Ulrich under the name of *Monotrypa rectimuralis* (Geol. Sur. of Illinois, vol. 8, 1890, p. 462) is similar in many respects to *M. undulata* Nicholson. Mr. Ulrich's species is described as massive, varying from lenticular to subspherical about four inches or more (10 cm.) in diameter: calices polygonal; surface generally smooth but occasionally with faintly elevated clusters of cells about one-half larger than the rest: corallites direct, with very thin straight walls, angular; tabulae few, complete and horizontal; no spiniform corallites.

He records this species as occurring at Cincinnati and in Illinois.

Dystactophycus mamillanum Miller and Dyer (Contr. to Pal. No. 2, July, 1878, p. 2), is a name given to what was supposed to be a sea-weed. It was described as mammiform or depressed conical, from eight to twelve inches in diameter and from one and one-half to four inches in height in the center. This "frond" was marked with concentric rings, twelve to eighteen in an inch. It presents no other characters, and it most likely represents an impression made by the epithelial membrane of the base of a large species of *Monticulipora*.

ECHINODERMATA.

This sub-kingdom includes the well-known sea-urchins, sea-cucumbers, sea-lilies, star fishes, etc. It contains a vast number of living genera and species, and was well developed in some of its classes far back in Paleozoic time. Its features are given by Dr. Nicholson as follows: *

"Simple marine organisms, which are mostly bilaterally symmetrical when young, but which in the adult condition have this bilateral symmetry more or less extensively masked by a radial (usually pentamerous) arrangement of their parts. An alimentary canal is present with or without a distinct anus, separate from the proper body cavity. A system of water vessels often communicating directly with the exterior, and generally connected with protrusible tubes (feet) is present. The nervous system is radiate, consisting of an œsophageal ring, and radiating branches. The integument is characteristically hardened by the deposition in it of carbonate of lime in the form of plates, granules, or spicules."

The sub-kingdom has been divided into two great divisions based on the absence or presence of a stalk. To the former belong the sea-urchins, the star-fishes, etc., and to the latter the crinoids. There is a further division into classes, and then into orders and families. In the present instance we shall disregard the two latter, inasmuch as it frequently occurs that single genera give their names to families; and the number of genera is not sufficient to justify in this place so minute a subdivision. The following classes are those found in the Cincinnati Group.

* Man. of Palæont, vol. i., 1889, p. 361.

Division A.—ECHINOZOA. *

Class 1.—ASTEROIDEA.

Here belong the star-fishes, whose characters may be given as follows:

Body star-shaped or pentagonal, consisting of a central disk, surrounded by five or more lobes or rays which radiate from the body, are hollow and contain prolongations of the viscera; integument coriaceous and strengthened by irregular calcareous plates, or studded with spines; dental apparatus none; mouth inferior and central; anus absent, or, if present, dorsal; ambulacral tube-feet protruded from grooves on the under surface of the rays.†

SYNOPSIS OF GENERA.

1.—PALÆASTER Hall. Disc present: ambulacral grooves deep, either wide or narrow; oval plates five or ten; two rows of plates on each side of groove, one adambulacral and one marginal row; three or more rows above.

2.—PETRASTER Billings. Disc present: ambulacral groove narrow; an incomplete series of plates between the adambulacral and marginal plates.

3.—PALASTERINA McCoy. Disc present: ambulacral grooves shallow; oral plates ten; marginal plates lacking, and only one row of adambulacral plates.

4.—STENASTER Billings. Disc absent: ambulacral grooves shallow: oral plates ten; adambulacral plates in one row, the marginal plates absent.

Genus 1.—PALÆASTER Hall, 1852.

Body stellate; rays five, occasionally seven, spinous, composed of five or more series of plates, generally two ambulacral, two adambulacral (one on each side of the ambulacral groove), and two

* Forms without a stalk.

† Nicholson, *Ibid.* pp. 391-392.

marginal; ambulacral grooves deep, wide or narrow, and bordered by strong spines; pores penetrating the plates of the upper surface. (Pal. of New York, vol. 2, p. 247.)

Remarks.—This genus is represented by quite a number of species in our section. An effort was made to arrange them in some sort of scheme by which their identification could be facilitated. Owing to the fact that in many cases only imperfect specimens are known, or else only the dorsal or ventral surface is known, and to the fact that the descriptions given by various authors do not always mention similar characters, this has been impossible. All that has been attempted, therefore, is to group the species according as the ambulacral groove is wide or narrow. In two cases the ventral side is unknown, so that these have been placed by themselves.

A.—Ambulacral grooves wide.

1.—*P. JAMESII* Dana, 1863.

Pentagonal; rays five, about two inches long from center of disc; body about one and one-quarter inches in diameter; marginal plates probably from twenty to fifty alternating with the ambulacral plates, which are about three times as wide as long; flat at the outer ends and raised into a conspicuous elevation near the ambulacral furrow, apparently about twenty-five in number, the inner edges interlocking in a peculiar manner; ambulacral groove wide: oral plates ten, in five pairs, each irregular in form, longer than wide, flattened and depressed at their outer ends; elevated into crest-like prominences farther in, and with a lateral process or thickening on the outer side of each; dorsal surface unknown. (Am. Jour. of Sciences, 2d ser., vol. 35, p. 265, as *Palæasterina*? : Pal. of Ohio, vol. 1, p. 62.)

Locality.—Cincinnati, O.

Remarks.—This species has attained notoriety by being figured in Dana's Manual of Geology and other places. It is one of the largest species of the genus and is well characterized and easily separable from all other species by the peculiar form of the oral plates. The type specimen is in the Walker Museum of Chicago University.

2.—*P. MAGNIFICUS* S. A. Miller, 1884.

Pentagonal: rays (if perfect) about two and three-eighth inches long; disc one and one-quarter inches in diameter; marginal plates

hexagonal, each with several small pits for articulation of spines; ambulacral groove wide; ambulacral plates in two rows, about fifty in each row, with their greatest diameter across the rows; adambulacral plates also fifty in number, hexagonal, much wider than long, more numerous than the marginal plates, alternating with them near the ends of rays, and having pits for articulation of spines; dorsal surface covered in part with convex, spine-bearing plates, generally a single spine to each plate; a single series of highly convex plates down the centre of each ray, and one on either side, the spaces between filled with smaller plates so arranged as to run diagonally from the side to the central row, and forming an angle with each plate in the central series. (Jour. Cin. Soc. Nat. Hist., vol. 7, p. 16.)

Locality.—Waynesville, Ohio.

3.—P. DYERI Meek, 1872.

Pentagonal; rays and body large, the former probably one and one-half inches long; body about two inches in diameter; marginal plates small, tumid, nearly square, alternating with a row of similar but slightly smaller adambulacral plates, the number in each series being about the same; both series roughened by coarse granules and possessing a pit for the insertion of a spine; spines smooth, straight, rounded, thickened at the attached end and tapering to a blunt point; ambulacral groove wide; dorsal side of disc and rays composed of numerous small pieces, with large pores between them, touching at three or four salient points, and thus forming a reticulated structure; each piece with a central tubercle having a minute pit for the insertion of a small, short spine; madreporiform tubercle flat, obtusely subtrilobate, with striations like the nervation of some ferns. (Am. Jour. Science, 3d ser., vol. 3, p. 257 Pal. of Ohio, vol. 1, p. 58.)

Locality.—Cincinnati, Ohio.

4.—P. GRANULOSUS Hall, 1866.

Pentagonal; rays five, a little more than twice as long as their breadth at the base, obtuse; body medium size; marginal plates small, tuberculose, about twenty-five on each side of a ray one and one-quarter inches long; ambulacral grooves broad, with two series of ambulacral plates slightly curved, each marked by an elevated ridge along its entire breadth; adambulacral plates smaller than the mar-

ginal ones, forty-two or forty-three in number, the basal ones (oral) ten, in pairs, small, elongated, subtriangular; upper surface of rays with numerous small, tuberculose or sub-spinose plates; madreporiform tubercle large, situated laterally at the base of two rays. (Rept. N. Y. State Mus. Nat. Hist., 1866, p. 285: 20th Rept. N. Y. State Mus. 1870, p. 327.)

Locality.—Cincinnati, O.

5.—*P. EXCULPTUS* S. A. Miller, 1881.

Pentagonal; diameter of body about 0.9 of an inch; rays a little longer; breadth of ray at body about three-fifths of an inch, obtusely pointed: marginal plates somewhat quadrangular, the first eight occupying about one-half inch; eighteen in one inch, and about twenty-five on each side of each ray; surface tuberculated and probably spinous; adambulacral plates about twenty-eight, narrower than, but about the same length as the marginal ones, spinous; a single somewhat pentagonal plate between the junction of marginal plates and of each ray; ambulacral furrow wide; each plate with a sharp ridge, increasing in height as it approaches the adambulacral row of plates. (Jour. Cin. Soc. Nat. Hist., vol. 6, p. 69.)

Locality.—Waynesville, O.

6.—*P. MIAMIENSIS* S. A. Miller, 1885.

Pentagonal; rays 0.9 inch long; diameter of body 0.6 inch; rays obtuse; marginal plates wider than long, about twelve in one-half inch from body, with two at junction of rays; ambulacral groove wide: ambulacral plates eighteen in one-half inch, each with an angular ridge; adambulacral plates about same size as marginal ones, and alternating with them, as shown by the figure, no mention being made in the description. (Jour. Cin. Soc. Nat. Hist., vol. 3, p. 143.)

Locality.—Waynesville, O.

7.—*P. SPINULOSUS* Miller and Dyer, 1878.

Body pentagonal; rays longer than diameter of body; marginal plates globular near ends of rays, but lengthened toward the bases, six measuring three lines; junction of marginal plates with body formed by two wedge-shaped plates; ambulacral groove deep and wide; ambulacral plates with their greatest length across the rays,

and with a sharp ridge in the middle; adambulacral plates a little smaller than the marginal, and with two or three spines to each, tapering to a point, and longer than the diameter of the plate; dorsal surface with irregularly-sized and strongly tuberculated or spinous plates; madreporiform tubercle an oblate spheroid, depressed and marked with fine radiating striæ. (Jour. Cin. Soc. Nat. Hist., vol. 1, p. 32.)

Locality.—Cincinnati.

8.—*P. DUBIUS* Miller and Dyer, 1878.

Pentagonal; rays longer than diameter of body, tapering to apex; body three-tenth inches in diameter; marginal plates unknown; ambulacral groove deep, angular, formed by two series of plates; each plate three times as long as wide, and fifteen plates in one-quarter inch on each side of each ray; adambulacral or oral plates and madreporiform tubercle unknown. (Contrib. to Paleont., No. 2, p. 5.)

Locality.—Cincinnati, Ohio.

9.—*P. FINEI* Ulrich, 1879.

Pentagonal, small; rays 0.3 inch long, rather broad, pointed, expanded about midway between the body and the point; marginal plates on dorsal surface twelve to fourteen, each with a pit for the articulation of a spine; on ventral surface convex, eleven to twelve, with a piece at junction of rays three times as large as any other, sub-circular and very convex; ambulacral plates with a sharp ridge, not alternating with adambulacral plates, which are nine to ten in number; dorsal surface of rays with four rows of plates, twelve to fourteen in each row, increasing in size toward the disc, which is composed of irregularly shaped and prominent pieces; madreporiform tubercle small, circular, very prominent and marked by strong striæ, which become more numerous toward the margin by intercalation of other striæ; rays sometimes only four. (Jour. Cin. Soc. Nat. Hist., vol. 2, p. 19.)

Locality.—Cincinnati, O.

10.—*P. ANTIQUATA* (Locke) sp., 1846.

Rays five, each about one and one-half inches long; marginal plates rounded; two rows of adambulacral plates at base of rays and

only one row at apex; ambulacral groove wide; ambulacral plates unknown. (Jour. Phil. Acad. Nat. Sci., vol. 3, p. 32, as *Asterias*.)

Locality.—Cincinnati, O.

Remarks.—This species can hardly be said to have been described by Locke, but the illustration given by him, although imperfect in many details, is plainly a *Palæaster*. The brief description given above has been drawn up from the figure.

11.—*P. SPECIOSA* (Miller and Dyer) sp. 1878.

Pentagonal; rays obtuse at apex and about 2.50 inches from point to point across body; breadth of body about 1.33 inches; marginal plates small and somewhat hemispherical, enlarging and becoming square near the ends of rays; rectangular as they approach the disc, until at the body they are twice as long as wide; about fifty marginal plates between the apex of one ray and the next one, thus making about two hundred and fifty in all; dorsal surface with many plates, very prominent or somewhat conical in the center, each having three to eight indentations, thus giving them a star-like appearance; ambulacral grooves narrow and deep; two rows of ambulacral plates coming evenly together and forming a sharp ridge. (Jour. Cin. Soc. Nat. Hist., vol. 1, p. 30, as *Palæasterina*. *Palæasterina approximata* M. & D., Ibid. p. 31.)

Locality.—Richmond, Ind., Waynesville and Preble Co., O.

Remarks.—This species was originally described as a species of *Palasterina*. The presence of the marginal plates would seem to exclude it from that genus, and we have therefore placed it in *Palæaster*. The species described as *P. approximata* presents so few points of difference that we regard it as a synonym. The dorsal surface of *approximata* is described as "coarsely granular." The space between the marginal and oral plates is stated to be filled by many smaller plates, and the madreporiform tubercle is "conical and striated longitudinally." The two latter features are not described under *speciosa*.

B. Ambulacral grooves narrow.

12.—*P. SHÆFFERI* Hall, 1866.

Pentagonal; rays five, acute, seven-eighths inch long; ambulacral groove narrow, with two rows of ambulacral plates of about equal

length and breadth near middle of ray; marginal plates moderately convex, twenty-two or twenty-three in number, gradually decreasing in size toward the extremity of ray, each plate marked by a scar for the attachment of a spine; adambulacral plates somewhat smaller, about the same number, alternating with marginal ones; basal pair of plates (oral) about ten, elongated triangular, slightly constricted near middle; upper surface of rays with three rows of sub-nodose plates, the outer rows with a strong spine on each plate. (Rept. N. Y. State Mus. Nat. Hist., 1866, p. 284: 20th Rept. N. Y. State Mus. 1870, p. 326.)

Locality.—Cincinnati, O.

13.—*P. SIMPLEX* M. and D. 1878.

Body pentagonal; rays longer than diameter of body and tapering; body four lines in diameter, and rays probably two inches in length when perfect; marginal plates nine or more, the one at the junction of any two rays large and angular-ovate, the smaller end extending up between two marginal plates, while the larger one extends into an angle formed by two adambulacral plates; ambulacral groove very narrow; adambulacral plates about twenty-two, somewhat oblong, their breadth extending along the length and their length across the ray; oral plates ten, irregular or elliptical, with a triangular extension into the oral opening. (Jour. Cin. Soc. Nat. Hist., vol. 1, p. 29.)

Locality.—Raysville, O.

14.—*P. LONGIBRACHIATUS* S. A. Miller, 1878.

Pentagonal; rays more than twice as long as diameter of body; breadth of body about six lines, length of rays about one and three-tenth inches; marginal plates spheroidal, gradually enlarging from tip to base of ray, about thirty-four, or a few more, in number, junction between rays formed by two pieces; ambulacral groove very narrow; ambulacral plates of the same form as, but larger than, marginal plates near ends of rays, but smaller than them near the body; no ambulacral plates within four plates of the two pieces at junction of rays. (Jour. Cin. Soc. Nat. Hist., vol. 1, p. 102.)

Locality.—Clarksville, Ohio.

C. Ambulacral grooves unknown.

15.—*P. INCOMPTUS* Meek, 1872.

Pentagonal, small; rays short, about 0.35 inch long and one and one-half times as long as broad, tapering rapidly to the apex and obtusely angular in form; body about equal to rays in diameter; dorsal surface of rays with three or perhaps four rows of plates, wider than long, about nine in each row, increasing rapidly in size toward the base: disc composed of smaller pieces; all the plates granulose but apparently spineless; madreporiform tubercle rather small, oval or circular, nearly flat and marked by fine irregularly interrupted striæ. (Am. Jour. Sci., 3d ser. vol. 3, p. 275: Ohio Paleont., vol. 1. p. 64.)

Locality.—Cincinnati, O.

16.—*P. CLARKANUS* S. A. Miller, 1880.

Pentagonal; rays one-half the diameter of the body; rapidly tapering to a point and one-fifteenth of an inch long; body two-fifteenths inch in diameter; marginal plates probably six on each side of each ray, with three series of interlocking plates on the dorsal surface of each ray between the marginal plates; madreporiform tubercle and ventral surface unknown. (Single specimen.) (Jour. Cin. Soc. Nat. Hist. vol. 1, p. 102. as *P. clarkei* Ibid., vol. 3, 1880, p. 236 as *P. clarkanus*.)

Locality.—Cincinnati, O.

Remarks.—The original name proposed for this species was *Clarkei*. It was subsequently found that this name was preoccupied and so the name *clarkanus* was substituted.

17.—*P. ANTIQUA* (Troost) sp., 1835.

Body of medium size; rays five, flexuose; marginal plates large, somewhat quadrangular, the outer faces subnodose; basal plates of the series single, broadly triangular, with slightly truncated lateral angles, the obtuse angle directed toward the axil of the ray; the small triangular space between the marginal and adambulacral plates filled by small granules or plates; adambulacral plates small, twice as numerous as the marginal ones; basal plates of the range elongated, triangular; ambulacral grooves with a single row of subquadrate ossicles alternating with the adambulacral plates; dorsal surface

unknown. (Trans. Geol. Soc. of Penn., vol. 1, p. 232 as *Asterias*. Hall. Adv. sheets 20th Rept. N. Y. State Mus. Nat. Hist., 1866; 20th Rept. same 1867, p. 287.)

Locality.—Big Harpeth River, Davidson Co., Tenn.

Remarks.—The description given by Troost is very imperfect. That given above is by Hall, who examined the type specimen and redescribed it, placing it provisionally in the sub-genus *Argaster*. This seems justified in the single row of ambulacral ossicles, the typical species of *Palæaster* having two rows.

Genus 2.—PETRASTER Billings, 1858.

“This genus has both marginal and adambulacral plates, with a few disc plates on the ventral side. The general form is deeply stellate and the rays long and uniformly tapering. A single specimen has been collected, and, as it shows the under side only, the character of the dorsal surface can not be given. The structure of the mouth is also unknown.” “It differs from *Palasterina* by the presence of large marginal plates outside of the disc plates.” (Canadian Organic Remains, decade 3, p. 79.)

Remarks.—The figure of *Petraster rigidus*, the type, shows only two rows of plates on each side of the ambulacral groove at the ends of the rays, and three at the base. There are only about seven plates in the central row near the disc, with a single plate at the junction of any two arms at the disc. This plate is nearly square with the angles directed toward the disc and outward between the rays. The description is very unsatisfactory and it might possibly be well to consider it as a synonym of *Palæaster*. Prof. James Hall states* that the type specimens of the genus, examined by him, are plainly referable to *Palæaster*. He places the following species in that genus. It is here kept distinct provisionally.

1.—P. WILBERANUS Meek, 1861.

Diameter in its larger part one inch, and in its smaller 0.33 inch; rays slender with two ranges of plates on each side of the ambulacral groove on the ventral side; about the same size in each row, and sometimes alternating; all rather prominent, those in the outer range projecting in the form of small nodes; about twenty-three pieces on each

* 20th Rept. N. Y. State Mus. Nat. Hist., 1867, p. 294.

side of the groove; groove very narrow; dorsal surface probably covered with small granules or bases of small spines, but this is not certainly known. (Proc. Acad. Nat. Sci. Phila., for 1861, p. 142.)

Locality.—Oswego, Ills.

Remarks.—This species is the only one so far referred to this genus from rocks of our group. In his description Meek considers it as related to *P. rigidus*, the type. The age of the rocks in which it was found is Trenton or Hudson River and it is inserted here in the hope that more information may be secured relating to it.

Genus 3.—PALASTERINA (McCoy) Salter, 1857.

Pentagonal, depressed, the arms a little produced, with three or five principal rows of tubercles above, combined with a plated disc which fills up the angles; ambulacra rather shallow, of sub-quadrate or slightly transverse ossicles, bordered by a single row of squarish, large plates, the lowest of which (*adoral* adambulacral plates, Huxley) are large and triangular, having combs of spines. (Brit. Pal. Foss., p. 59 (proposed but not described); Salter. Ann. and Mag. Nat. Hist., ser. 2, vol. 20, Nov. 1857, p. 324. Billings, Canad. Org. Remains, decade 3, 1858, p. 76.)

Remarks.—Two species have been referred to this genus from our region, but as already noted they are said to have marginal plates, which are absent from the present genus. They have therefore been referred to *Palæaster* and will be found under *P. speciosa*. (M. and D.) sp.

Genus 4.—STENASTER Billings, 1858.

No disc; rays linear, lanceolate or petaloid; grooves bordered by solid oblong or square adambulacral plates; oral plates triangular, ten; two rows of ambulacral pores; dorsal side of disc and rays covered with small plates which appear to be tubercular and not closely fitted together. (Canadian Org. Remains, Decade 3, p. 77.) *Urasterella* McCoy, 1851. Proposed but not described)

Remarks.—It has been proposed by Prof. Hall* to adopt the name *Urasterella* for *Stenaster*. The argument advanced is that the two genera are equivalent and McCoy's name has precedence. As far as date of proposal is concerned this is so, McCoy's name dating

* 20th Rept. I. c. p. 289.

from 1851 and Billings's from 1858. But McCoy did not describe his genus, simply referring two species to it. Hall considers that *Urasterella* and *Palasterina* stand on the same footing as they were proposed at the same time and in the same place. But *Palasterina* was regularly described by Salter in 1857. *Urasterella* has never, so far as known, been described at all. We have, therefore, retained the name given by Billings.

1.—S. GRANDIS Meek, 1872.

Attaining a very large size with the body or disc comparatively small or only the breadth of the united inner ends of the five rays; rays long, slender, gradually tapering and very flexible, widest at their immediate connection with the body where they seem to be more or less depressed, but becoming more nearly terete further out; dorsal surface of disc and arms composed of numerous subtrigonal pieces that rise into pointed tubercles or sometimes assume almost the character of short spinules, and arranged in quincunx order, so as to form about eight rows near the middle of the rays; those of the two outer rows slightly larger than the others; dorsal pores apparently rather large, and passing through between the concave sides of contiguous pieces; ventral surface of disc unknown; ventral surface of rays with a single row of transverse, adambulacral pieces on each side of a well defined, rather deep and moderately wide ambulacral groove; adambulacral plates rather more than twice as long as wide, with their longer diameters at right angles to the ambulacral groove, and rounding over from end to end so as to be more prominent in the middle, connecting with each other by small projecting processes and corresponding sinuses on the opposite side; breadth of disc 0.63 inch; length of rays 2.40 inches; breadth at junction with body 0.36 inch; diameter from tip to tip of rays 5.50 inches. (Am. Jour. Science, ser. 3, vol. 3, p. 258; Pal. of Ohio, vol. 1, p. 66.)

Locality.—Richmond, Ind.

Remarks.—Prof. Meek in his remarks in Palontology of Ohio quotes with approval Hall's suggestion as to the use of *Urasterella* for *Stenaster*, but as already noted we have preferred to retain the latter name.

2.—S. HARRISI (S. A. Miller) sp. 1879.

Body pentagonal; rays twice as long as diameter of central part of body, flexuous, uniformly tapering to an acute point; marginal

plates wanting; ambulacral furrow narrow; ambulacral plates in two rows; adambulacral plates small, flattened, sub-circular, twenty-five or thirty in number, gradually decreasing in size from apex to base of rays; oral plates ten, each somewhat triangular; dorsal surface of rays with three (?) rows of plates, extending over the adambulacral row on ventral surface. (Jour. Cin. Soc. Nat. Hist., vol. 2, p. 117, as *Palæaster harrisi*.)

Locality.—Waynesville, O.

Remarks.—Although originally described as a species of *Palæaster* the distinct assertion that the marginal plates are wanting seems to take it out of that genus, where the marginal plates is a chief characteristic. We have therefore, ventured to put it into *Stenaster*.

Class 2.—OPHIUROIDEA.

To this class belong the “brittle-stars,” or those forms of star-fish that lose their arms readily on being disturbed. It may be defined as follows:

Body stellate, consisting of a central disc containing the viscera, and of elongated, often flexible arms, which are sharply defined from the disk, do not contain prolongations of the alimentary canal, and are without open, ambulacral grooves on the *under surface*.*

Genus 1.—PROTASTER Forbes, 1849.

“Body circular, covered with squamiform plates; genital openings in the angles of junction of the arms beneath; arms (simple) formed of alternating ossicula. (Mem. Geol. Sur. Gt. Britain; decade 1, pl. 4.)

Remarks.—The above is the original description given by Forbes. Salter in 1877 (Ann. and Mag. Nat. Hist., 2d ser. vol. 20, p. 325), re-defined it as follows: “Arms elongated, extending much beyond the circular, closely reticulate disc; the arms are composed of two rows of deeply sculptured plates, spinous at the edge, and below of two rows of elongated ambulacral ossicles, bordered by a row of large spinous plates; the basal ossicles of the ambulacra, bordering plates and disc, combined to form a petaloid mouth below.” Another feature still is the presence of bunches of lateral spines on the plates

* Nicholson, Ibid. vol. 1. p. 399.

of the ventral surface. Two species have been referred to the genus from our region, as given below.

1.—*P. (?) GRANULIFERUS* Meek, 1872.

Disc small, apparently circular; rays rather slender and of unknown length; dorsal surface covered by an integument composed of innumerable minute grains of calcareous matter; ventral side of disc apparently provided in the interradian spaces with minute spines directed outward; arm pieces regularly alternating, and apparently rectangular at their inner ends and not interlocking along the minute mesial impressed line, wider than long, each excavated at the anterior outer end so as to form a large pore or pore-like depression and divided transversely by a furrow into two parts, the anterior end very short and the posterior longer, marked by a minute pit at its inner end; about eight or nine pieces in each range of each row, included within the margin of the disc; outer arm pieces (adambulacral) smaller than those of the inner ranges, and placed, edge upwards, with an oblique outward direction, so as to imbricate toward the extremities of the rays; each bearing one or more minute articulating spines; breadth of disc 0.43 inch; breadth of arms at their inner ends 0.10 inch. (*Am. Jour. Sci.*, ser. 3, vol. 4, p. 274.)

Locality.—Moore's Hill, Indiana.

2.—*P. MIAMIENSIS* S. A. Miller, 1882.

Disc four lines in diameter; rays one inch long, flexuous and tapering to a point; dorsal surface unknown; ventral surface between the rays with the plates so anchylosed that "no special definition of them can be given;" rays with two series of sub-quadrangular ambulacral ossicles alternating with each other at the bottom of the ambulacral plates with spines; oral plates five. (*Jour. Cin. Soc. Nat. Hist.*, vol. 5, p. 116.)

Locality.—Waynesville, O.

Remarks.—This is a very unsatisfactorily defined species and needs fuller material.

Genus 2.—*TÆNIASTER* Billings, 1858.

"Body deeply stellate; no disc or marginal plates; rays long, slender, flexible, and covered with small spines; two rows of large

ambulacral pores; adambulacral plates elongated, sloping outwards so that they partly overlap each other; adambulacral ossicles contracted in the middle, dilated at each end." (Can. Organic Remains, decade 3, p. 80.)

1.—T. ELEGANS S. A. Miller, 1882.

Body deeply stellate; rays long, slender, flexible, margined on either side with a row of spines; probable diameter from tip to tip of rays one and one-quarter inches; dorsal surface of rays rounded with a single row of plates; ventral side marked by a furrow in the center, separating two series of plates or ossicles; plates slightly longer in the direction of the ray than across it, breaking joints alternately in the center where they are slightly contracted. (Jour. Cin. Soc. Nat. Hist., vol. 5, p. 41.)

Locality.—Waynesville, O.

Genus 3.—PROTASTERINA Ulrich, 1878.

Rays five, slender, flexible, and extending much beyond the circular and minutely granular disc, which is provided with short, slender, outwardly directed spines; inner ray pieces regularly alternating, of an hour glass shape, and interlocking along the median line; outer ray pieces elongated, directed obliquely outward, so as to partly overlap each other; two rows of large pores between the inner and outer ray pieces, which in some species appear to have been occupied by loosely-fitting, sub-pyramidal plates, some of which have a deep depression in the top, as though perforated; oral plates ten, each pair formed by two of the outer ray pieces. (Jour. Cin. Soc. Nat. Hist., vol. 1, p. 95.)

1.—P. FIMBRIATA Ulrich, 1878.

Disc of medium size, circular; dorsal surface covered with a granular integument; ventral surface with a large number of outwardly directed short and slender spines; oral plates ten, the inner edges with five spines, while extending from each pair over the mouth, is a bundle of rather long spines; rays apparently very flexible, contracted toward the mouth; six series of plates on the ventral surface of each ray, the two middle series alternating and interlocking along the mesial line, and twice as long as wide; each contracted in the middle on the inner side to admit the wide edges of the two immediately opposite, forming on the outer side a pore-like impression; four plates in each

range of each ray are included within the disc, the series ending abruptly about one and one-half lines from the oral plates; sixteen plates in each range on the rays; pores apparently closed by obtusely conical or pyramidal plates, some with a depression in the top; marginal plates flat placed on edge and directed outward so as to overlap each other, the edges toward the ventral surface and pointing toward the ends of the rays, lined with ten or twelve short, club-shaped spines; dorsal surface of rays with two rows of alternating and interlocking plates, deeply sculptured near the disc and about as long as wide, becoming gradually less excavated and longer in proportion to the width at the tips of the rays; on each side they articulate with the upper edge of the oblique marginal plates; disc 0.60 inch broad; rays 0.16 inch broad at disc, and 0.88 inch long from the oval plates. (Jour. Cin. Soc. Nat. Hist., vol. 5, p. 95.)

Locality.—Covington, Ky.

Remarks.—In this lengthy description we have many of the generic characters repeated. The author says it is “related to *Protaster flexuosus*.” M. and D.

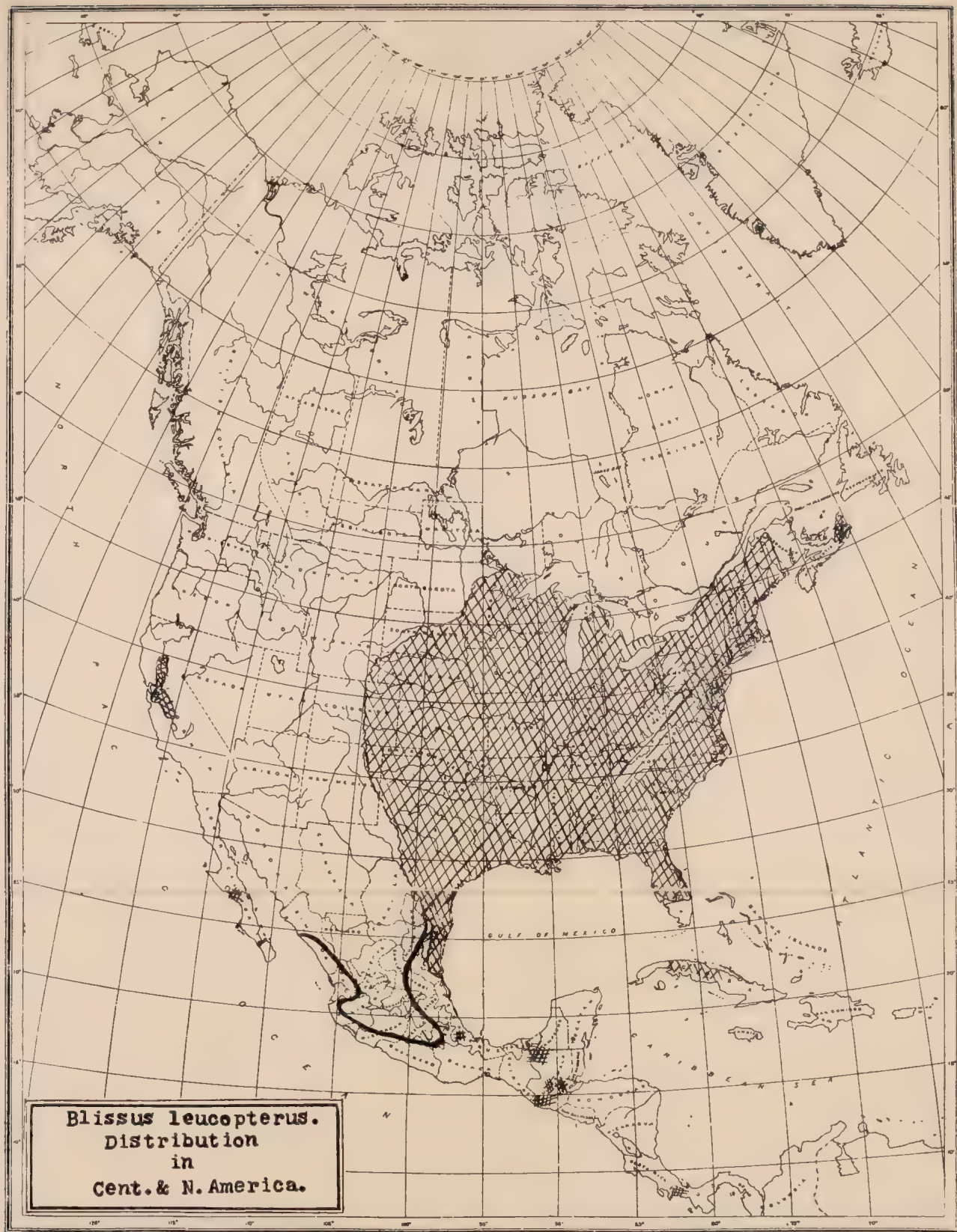
2.—*P. FLEXUOSA* (M. and D.) sp. 1878.

Disc varying in diameter from one-quarter to one-half inch, composed of very thin, small plates; rays very flexuous, the dorsal surface with four series of plates on each side near the disc, the two inner forming an angular ridge, alternating, and presenting an appearance like two series of hour-glasses; outer or marginal plates spinous, the spines directed toward the apex of the ray; three series of pores on the rays; plates slightly longer than wide and about four to one line; rays cross the disc on the dorsal side and unite near the centre; ventral surface with two rows of spines springing from the marginal plates on each side of the rays. (Jour. Cin. Soc. Nat. Hist., vol. 1, p. 31 as *Protaster*.)

Locality.—Cincinnati, O.

Remarks.—This species seems to present an aggregate of characters which justifies in placing it in *Protasterina*. The principal one of these characters is the interlocking series of plates presenting the hour-glass appearance.

(To be continued.)



THE PROBABLE ORIGIN AND DIFFUSION OF BLISSUS
LEUCOPTERUS AND MURGANTIA HISTRIONICA.*

BY F. M. WEBSTER, M. S.

That anything new could be said of an insect, so old and well-known as *Blissus leucopterus*, the common Chinch Bug, would appear almost incredible, for it probably has been more often discussed than any other of our insect fauna, in our entomological publications, especially such as deal with entomology as one of the agricultural sciences, and by entomologists whose names will forever be connected with the science of entomology in this country. An examination of the literature of this species, however, will show that much of it is, to a great extent a repetition of the older writers; and we seem to have been going on in this way, without stopping to ask ourselves whether or not these older writers were strictly correct, and whether their statements would stand the test of modern, severe scrutiny. The old and commonly accepted theory, in regard to the original habitat and later diffusion of this species, is that it originally occupied the country along the Atlantic, throughout Virginia and the Carolinas, from whence it spread westward in the wake of grain growing. The theory is based upon the fact that it is from these localities that reports first came of its ravages in cultivated fields; and it was described by Thomas Say while residing at New Harmony, Indiana, from a specimen from this locality, and therefore, it is supposed, must have afterwards spread westward and northward. Now while I am free to say that this theory *may* be the correct one, we have really no proof whatever to sustain it, while we do know that over its entire habitat, in North America at least, it is fully capable of sustaining itself on both wild and cultivated grasses, and that its occurrence does not depend

* Read before the Ohio Academy of Science, December 28, 1895.

upon the extent to which the country is given to grain growing. "C. L. W.," in the "*Farmers' Review*," (Chicago, Ill.) Nov. 2nd, 1887, states that he had been farming in Smith county, Kansas, ever since the county was first settled, and the first crop of corn that he raised there was planted on sod, (*i. e.* recently broken virgin soil) and was covered with chinch bugs though there was no grain to speak of within one hundred miles of the field. I have found it in the alluvial portions of Louisiana, where very little corn, only, is grown, far more abundant than in Northern Indiana, where the area devoted to grain growing is vastly more extensive, while in the latter region it was not one per cent. as numerous as in portions of Illinois where the area cultivated to grains was no more extensive; all of the localities being topographically much alike in character. In 1894, Dr. J. C. Neal, of Stillwater, Oklahoma, wrote me that he had found these bugs in that territory, miles from human habitation, in immense numbers and at the roots of the native grasses. In 1854, Dr. Fitch found them in autumn, in Northern Illinois, amidst extensive prairies, where, on parting the grass, the ground was covered and swarming with them¹. The outbreak in New York, in 1882 and 1883², was not in the grain fields but in timothy meadows. In 1884, Mr. W. H. Harrington, took it abundantly along the sea shore, at Sydney, Cape Breton, clustered on bunches of grass³. Prof. Otto Lugger, found them destroying timothy near the shores of Vermillion Lake in Northern Minnesota, where the only agricultural product besides was potatoes⁴. In his short paper in *Insect Life*, Vol. VII., pp. 232-234, 1894, Mr. C. L. Marlatt, calls attention to the fact that in Kansas he found these insects hibernating in great numbers in the dense stools of some of the native grasses. So marked was this hibernating habit that Mr. Marlatt questioned if this was not the "normal and ancient habit of the species, the natural food-plant of which, before the advent of the white man and the growth of cereals, must have been some of the native grasses." In commenting on Mr. Marlatt's note, in *Insect Life*, Vol. VII., p. 420, Mr. E. A. Schwarz states that "the same habit of clustering about the roots of tufts of grass is at present to be observed along the Atlantic coast from Cape

1. First, Second Report, Insects of New York, p. 283.

2. Lintner, Second Report, State Entomologist, N. Y., p. 159.

3. Can. Ent. Vol. XXVI, p. 218.

4. Bull. 37, University of Minn., 1895.

Florida to Atlantic City, New Jersey," and adds that "the unique appearance of the fullgrown chinch bug, with its white wings and chalky white pubescence, forcibly indicates that the insect is either a psammophilous or maritime species"; and he further expresses the opinion that its geographical distribution fully bears out the theory that it belongs to the latter class. It will be observed that this habit of clustering about the tufts of grass, along the sea shore is borne out by Mr. Harrington's observations, much farther northward. It appears to me that Mr. Schwarz, in his statement that the species is probably a maritime one, has given us the key to the whole problem, and I shall discuss this factor, at length, farther on, and will only here suggest that it is sub-maritime instead of maritime, and also add to the mass of proof there presented, going to show that the species is capable of sustaining itself on grasses, by calling attention to the fact that during the recent outbreak in Ohio, almost without exception, all of the complaints of ravages in the north-eastern part of the State were of injuries to grass. It seems to me that we now have before us ample proof that this insect may not only exist, but become abundant, perfectly independent of cultivated grains.

The question of a westward advance of the species from the Atlantic coast, is however, a valid one and must be carefully considered. Fitch states, in his second report, p. 278, that the insect first began to prove destructive in North Carolina in 1783. Webster, in his work on Pestilence, Vol. I, p. 279, states that, in 1785, fields of wheat in North Carolina were so overrun with these insects as to threaten total destruction to the grain. Now, if I mistake not, North Carolina had, at this time, become about as thickly populated, and agriculture had advanced to about the same magnitude, that it had in the west when the species first began to attract attention in 1823 in Southern Illinois, 1850 in Northern Illinois, 1855 in some portions of Iowa, and in Kansas, Nebraska and Minnesota later on. That is, these insects began to attack cultivated plants over the whole area of their present habitat, where they have been destructive, at about the same period of agricultural development, and density of rural population. The trend of these has been westward, but the fact does not prove the non-occurrence of *Blissus leucopterus* in considerable numbers, prior to the advance of this wave of civilization and agricultural progress. The only data upon which the assumption that the two phenomena were co-existent, is, so far as I am aware, based on the fact

that the species was described by Thomas Say in 1831, while resident of New Harmony, Indiana, the description being drawn up from a specimen from the eastern shore of Virginia, while he at no time mentioned its occurrence elsewhere. Prof. S. A. Forbes, in the Sixteenth Report of the State Entomologist of Illinois, p. 50, presents conclusive evidence of the occurrence of this species, as early as 1823, in Southeastern Illinois, and within twenty-five miles of New Harmony, Ind. Say was a very busy man and may or may not have known of this occurrence. Besides, in the Proceedings of the Indiana Academy of Science for 1891, p. 158, I have shown a parallel case in which Say seems to have overlooked species that occurred even nearer to his home than this.

The only species of *Simulium* described by him was *S. venustum*, which he found at Shippingsport, Falls of the Ohio. This is the falls at Louisville, Kentucky. There are at present at least two species of *Simulium* inhabiting the Wabash River, within a short distance (probably less than a mile) of New Harmony, and an oil painting by LeSueur, now in the possession of the Owen family, shows that at an early day this was even better adapted for a breeding place for these insects than at present, and in all probability at least two species did occur there unrecorded by Say. Thus the only data upon which to base the assumption that the chinch bug moved westward with the advance of agriculture is swept away, and we are forced into the conclusion that it would have been able to sustain itself on the native flora, and that there is nothing to prove that it did not do so. The fact of its attacking cultivated plants, later on in the progress of agricultural development, does not by any means necessarily imply a recent introduction. All or nearly all native insects adapt themselves to cultivated plants only when forced to do so by the encroachment of the latter upon their natural food plants, and I think we can show that *Blissus leucopterus* is not an exception.

Fitch, Marlatt and Neal, have all observed the species hibernating among the native grasses, or else found them in late fall or early spring in situations indicating that they had done so, and in the case of Dr. Neal, this was observed a long distance from human habitation. The aborigines, we know, were in the habit of burning over the prairies and other grass producing areas, in the fall of the year, which must necessarily have destroyed vast myriads of these insects after the season of hibernation had begun. With the retreat of the

Indian came a decline in prairie fires, and the early settler, beginning where the Indian left off, burned over the uncultivated areas in the fall to protect his buildings, or the dried grass, was fired by sparks from locomotive engines passing over widely separated lines of railway. But gradually these tracts of native grass lands would become so interspersed with cultivated fields that prairie fires as we have termed them, no longer occurred. In his second report already referred to, Dr. Fitch states that at Sandwich, Illinois, the insect began its ravages in wheat fields in 1850. This was ten years after the Pottawattama Chief, Shabbona, and his tribe abandoned the country, and two years before my father settled in that immediate locality, and I know from personal experience that there was then only a limited cultivation of grains, and a decline in the burning over of the grass lands in the fall, was followed by rapid increase in the abundance of this species, and in a locality where all available information points to its having been able to sustain itself and increase in numbers while subsisting upon the native grasses. I feel that I am justified in supposing that a similar condition would result in a corresponding increase elsewhere.*

We will now turn to Mr. Marlatt's suggestion that the clustering about the roots of tufts of grass is the normal and ancient habit of hibernation. But I shall go farther and add, also, the gregarious habits of the larvæ and pupæ; Dr. Fitch witnessed this mode of hibernation in Illinois, in 1854, while Dr. Neal observed the same phenomenon in Oklahoma, in 1894, forty years later, so that we have absolute proof that the habit has been followed at several, widely separated, inland points, for nearly half a century; and Mr. Schwarz has shown that this habit at present prevails along the sea coast, from 1,000 to 1,500 miles distant. Along the coast, where grass grows in tufts, it is absolutely necessary for these insects to congregate together in masses, but in the Mississippi basin, or at least over the greater portion of it, the grasses are much more evenly distributed, yet we find the habit as closely adhered to as elsewhere, except it be in patches of closely matted blue grass. Probably no one, however unobserving, has failed to notice the persistency with which the larvæ and pupæ adhere to their gregarious habits. That the very young

* Professor Lugger writes me that the insect does not occur in his State on the prairies, but in the timbered portions, except where covered by pines.

should be found in numbers about a clump of grass or grain plants is not surprising, as a large number of eggs deposited in such places would account for their numbers, but after crossing a roadway or plowed field, and reaching evenly distributed plants on the opposite side, they do not spread themselves out over any considerable territory, but even when their numbers are limited, they will congregate on a few plants, precisely as if they had, somewhere, been obliged to follow this habit, during a long period of time, as a necessary precaution against extermination. That this characteristic habit should be followed throughout a period of fifty or even one hundred years, in a locality where such was not only unnecessary, but even detrimental, is not at all improbable, so long as it does not threaten the extermination of the species.

Mr. W. H. Hudson in his "Naturalist in La Plata," p. 241, informs us that, on the pampas of South America, some of the woodpeckers seek their food on the ground and also nest in the banks of streams, yet even where their living in the midst of treeless plains has resulted in structural modification in accordance with their altered way of life, they still retain the primitive habit of clinging, vertically to the trunks of trees, although the habit has lost its use. And, again the same author, on page 18 of the same work, tells us of a species of opossum, *Didelphys auritus*, also on the same pampas, and while every way fitted for an arboreal life, yet is everywhere found on the ground where it has probably been a dweller for thousands of years, but if one is brought to a tree it will take to it as readily as a monkey. Why, then should not *Blissus leucopterus* retain its maritime instincts on the American pampas of the Mississippi valley? There is another characteristic habit of this species that we may, perhaps, trace back to some ancient time when it was essential to the perpetuity of the race. Although Dr. Packard has found it on the summit of Mount Washington, New Hampshire, at an elevation of 6,300 feet, and Prof. Gillette writes me of its occurrence, rarely, near Fort Collins, Colorado, at an altitude of 5,500 to 6,000 feet, inside the foot hills, Prof. Cockerell, who collected carefully in Colorado for several years, about West Cliff, Custer County, at an approximate elevation of 7,000 to 8,000 feet, did not find it at all. It is reported from Volcan de Chiriqui, Panama, at an elevation of 6,000 feet. (Biologia Centrali-Americana, vol. I, p. 196.) How common Dr. Packard found it on Mt. Washington, I do not know, but as Mrs. Slosson has collected very carefully on the moun-

tain at various times since without securing it at all, I infer that it occurs there but rarely, and as Packard's date was August, in the midst of mid-summer migrating season, we may, in North America, safely look upon its occurrence at that time as due to its nomadic habits. Prof. Gillette, as he writes me, has found but three or four specimens, probably stray individuals. How abundant it was found on the volcano in Panama, I have no means of learning, but I believe we can safely say that its occurrence in high altitudes is due to its somewhat roving habits, especially at the periods of migration, which, while it strengthens the idea that the insect might have crossed the Alleghany Mountains at an early day, to precisely the same or even a greater extent does it strengthen the theory of an early spread over a much more level country, from the south. Therefore, we may safely say that its normal habits is at an altitude of from a few to 1,000 or possibly 1,200 feet above sea level. It is a plain-loving species and, according to my own experience, running over some forty years, it prefers a clay to a sandy soil. I believe with Mr. Schwarz that it is not a psammophilous but a maritime species (or semi-maritime, as I would put it) not a sand-loving but a coast-loving insect. It certainly does not especially favor the near vicinity of the shores of the great lakes, and I have never found it in close proximity to any of these except in limited numbers. The outbreak in New York, previously mentioned, is the only instance on record where it has occurred in abundance close to any of the Great Lakes, and this case hardly constituted an exception as the outbreak was more especially along the St. Lawrence River, and some thirty or forty miles from the eastern shore of Lake Ontario. To offset this, over the lower peninsula of Michigan and Northern Indiana, both lying between Lake Erie and Lake Huron on the east and Lake Michigan on the west, the country is almost uninhabited by the species, it being impossible to find after continued search in favorable localities, more than an occasional specimen, and I believe this to be true also of Ontario, Canada, north of Lake Erie, even at a time when from Western Indiana, westward to beyond the Mississippi River, they were proving a veritable scourge. (See fig. 1, on next page.) Hence, while it is sea-loving, it cannot be said to be lake-loving, clearly preferring the proximity of salt to fresh water. I have stated that it is a plain inhabiting insect, but it may inhabit very limited, flat areas, interspersed among those more broken and elevated.

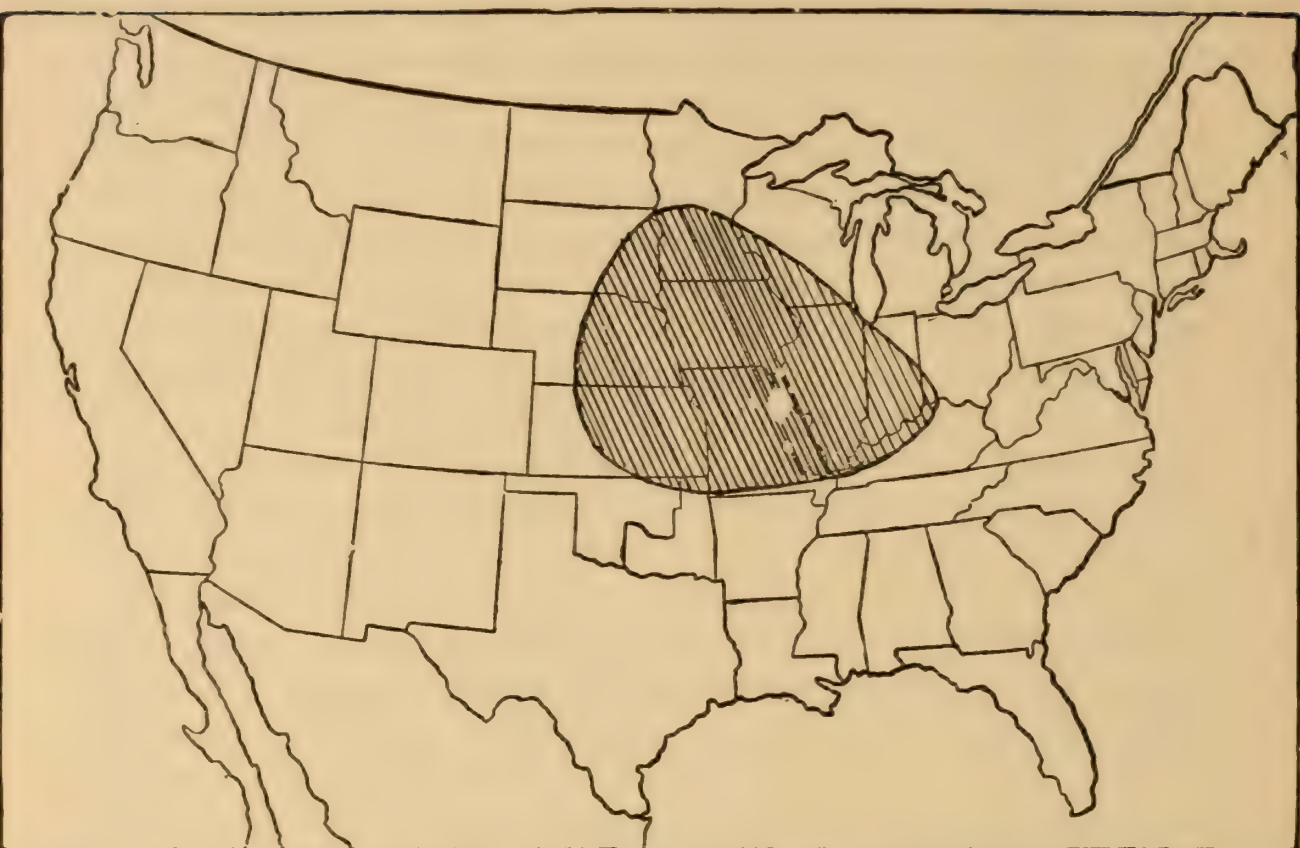


Fig 1. Approximate area in North America over which *Blissus leucopterus* occurs in greatest abundance.

As illustrating this habit in Ohio, I may state that in 1894, I found it quite abundant in Champaign, Logan and Hardin counties, with its greatest abundance in the latter and Wyandot county, to the northeast, the two latter being of a more level topography than the two former. In 1895, the area of greatest abundance included only Wyandot and a portion in Hardin counties, Champaign suffering but little, while to the south of Green and Clarke counties, where, in 1894, I had found it sparingly, it did not occur in abundance at all, thus showing that it had drifted to the lower and flatter lands to the east, except in Wyandot and a portion of Hardin, where these conditions already obtained, and overrun a wide range of practically flat country having a clay soil. A portion of the state lying to the west and northwest of Lake Erie, being the ancient bed of the preglacial lake, and the soil sandy instead of clayey, was little if at all infested, whereas, the flat, clay lands, to the south and west were in some localities literally overrun with these insects. Now while the species appears to inhabit low, flat lands, by preference, there is one phenomenon that is seldom mentioned by those writing or speaking of its habits, and

that is the quite general preference shown by the females in selecting any slight elevations in the fields, such as hummocks or even what are known in agricultural parlance as "back furrows," where two furrows are thrown together forming a slight ridge, as places for ovipositing; and I have noticed in large fields of comparatively low, flat land, that the wheat on these slight elevations would turn white and die from attack while the lowest portions would remain uninjured; precisely as if the females had expected to avoid all probability of their progeny being submerged by a sudden, excessive rain fall, tides, or unusually high waves, such as would be likely to occur in a tropical country or along the sea shore. It seems to me that we may here have another illustration of an ancient habit, formerly followed throughout a long period of time, through necessity, and now by inherited instinct.

Mr. Schwarz has cited the extreme susceptibility of *Blissus leucopterus* to the influence of moist weather, as being in striking contrast with the behavior of other insects which are native to the states inhabited by it in North America, and thinks that this, with the fact that it seems almost wholly free from parasites, points strongly to its being an immigrant from some other more or less distant habitat. I would not only coincide in this opinion, but beg permission to add three other, so far as I can see, equally strong points. Lack of variation from the type, would indicate a strict adherence to old established habits, or a short residence in North America, while the frequent occurrence of adults with aborted wings would imply that it had, sometime, lived where either the wings were useless or else their use would render the possessor liable to be blown out to sea. Darwin in "Journal of Researches" has called attention to the probability of insular insects either being provided with especially strong wings, or none at all, in order to protect them from being carried away by the wind. This, of course, does not apply to such species as are apterous in one generation and winged in the other, like *Isosoma tritici*, or where the female alone is apterous, as in *Anisopteryx* and *Orgyia*, in Lepidoptera, and *Tyloderma fragariae* in Coleoptera. It is easy to see that a species as migratory as the chinch bug, if inhabiting a narrow tract of land swept by cross winds, would have need of such a protection, and, in fact, Mr. Schwarz finds it apterous along the east coast of Florida, so that we here have an occasionally appearing character that may, inland, be the remnant of an ancient condition. That *Blissus leucopterus* is only very slightly variable is quite in harmony with the whole

group, *Blissina*, its nearest relatives being every one found in Mexico.

Mr. Schwarz, in his note previously referred to, calls attention to the marked susceptibility of the species to moist weather, as in decided contrast with other species occurring in the same region. This, it seems to me, needs further explanation. It is quite probable that the effect of moist weather on the adults has been over estimated, and besides moist weather inland is one thing, while the same degree of moisture along the sea coast where the air and soil is strongly impregnated with salt, is quite another. Besides, a few drenching rains during the hatching season will destroy more young than almost any amount of rain will destroy adults. I believe the adult is, directly, little if at all affected by moist weather, even away from the sea shore. That it is destroyed in myriads, by the fungus, *Sporotrichum globuliferum*, is certainly true, but I believe this will be found more owing to the gregarious habits of the insect, both while young and when fully developed and in its hibernaculum, than any peculiar weakness or susceptibility. There is scarcely room to doubt that the salt in the sea air and in the soil along the coast would have a tendency to counteract the effects of this fungus, though it is nowhere likely to do more than reduce an over abundance.

I have but one more point to make in this connection and this is a philological one. The common name of this insect, chinch bug, is, we are told by Fitch, a Spanish name, given the species because of the resemblance of the young larvæ to the young of the bed-bug, *Cimex lectularius*, and the disagreeable odor of the two have, also, a strong resemblance. In the southern portion of the country, the latter species is even, at present, known to the people in general as chinch bugs. It is, perhaps, worth while to call attention to the curious fact that *Blissus leucopterus* is at present an inhabitant of Cuba, Mexico and Central America, southward at least to Panama, and also of Florida, which was under Spanish rule until long after the name "chinch bug" was applied to this species; and, with the exception of Florida, the Spanish language has always been and is yet the one in common use, except among the aborigines. While it will be too much to say that the insect was christened by a Spaniard, we are in as much of a dilemma, when we attempt to determine just where and how far south this name "chinche," was first applied to it.

If ancient habits and environment have left their marks on the modern characteristics of this species, and I have translated these

vestiges aright, we should, as Mr. Schwarz has previously stated, "look for the true home of the chinch bug near the sea shore," congregating on tufts of grass, both in its early stages and as hibernating adults, where the land is under 1,000 feet elevation, and usually but a few feet above high tide, on an island, peninsula or isthmus, and north of the equator. The soil may be either sand or clay and the surface comparatively level, in occasional areas if not in general, and where the wind will have full play; and we would expect to meet here other species more or less closely allied to it, and we might further expect it to be able to survive for an unusual length of time in sea water. In neither the Islands of Granada or Cuba, or in Florida do we find species as closely allied to *Blissus leucopterus* as in Mexico, where, according to Uhler's check list, all of the North American species of the group *Blissina* occur, except *Ischnodemus falicus* Say, which Mr. Uhler himself says occurs in Texas, Dakota, Kansas, Louisiana and the United States generally east of the Mississippi basin, specimens from the sea coast of Maryland and North Carolina sometimes attain double the size of those found inland, moisture and warmth seeming most favorable to its greatest development. However, even this apparent exception may have had a precisely similar origin, as *Ischnodemus præculatus*, a very closely allied species, is found in Guatemala, and it is not at all improbable that it is from this that *I. falicus* originally sprung and spread northward into North America. *Blissus leucopterus* is the sole member of the genus in Central or North America, so far as now known, which of itself would lead us to look toward South America for closer relatives. On the Island of Granada, one of the Lesser Antilles, not far distant from the coast of Venezuela, it is reported as being of a larger size and more variable in color, indicating a longer residence than in North America. It has not been found on any of the islands between Granada and Cuba, and if this was its pathway to the coast of Florida, it will be observed that both the trade winds and the current would drive them westward instead of northward, so that its occurrence on these islands was possibly brought about by two distinct introductions, one from the south the other from the west or north, most likely the former. We know of its occurrence in Panama, across which the trade winds blow unobstructed, the elevation being in some places less than 2,000 feet so that it might here become distributed along both the eastern and western coasts and work along both to the northward. Along the west coast it has

been reported from Panama, not far from the border of Costa Rica, Guatemala, Lower California and California along the coast near San Francisco and in the Sacramento valley. On the Atlantic and Gulf coasts, it has been reported from Panama, Tabasco and Mexico at Orizaba and in the State of Tamaulipas, which is located on the coast south of the mouth of the Rio Grande. Along the Atlantic it is known from Florida to Cape Breton. It seems to me that a much more reasonable theory would be to suppose that the species originated either in Panama or in either the valley of the Atrato or the Magdalena River, of the United States of Columbia or perhaps along the Venezuelan coast in South America (and it is here that I fully expect a much closer ally than now known to be discovered), and that it has simply followed the moderately low lands, which would of necessity be located in rather close proximity to the coast, until it reached eastern Texas and Louisiana, where it not only continued to work its way eastward on account of its maritime nature, but also pushed its way northward under the inducements offered by a moderately level, slightly elevated country, producing a grass flora upon which it could readily sustain itself, thus giving it a northern and eastern, but at no time a western spread. The very narrow limit of the land in Panama would compel the insect to confine itself rather closely to the sea shore, but a little farther north, it seems in a slight degree to break away from the immediate coast, and inhabit the low lands adjacent, so that it would, even this near its native home, appear to have become a semi-maritime species, just as I would designate it at present, and which would account for its distribution and habits as we now find them.*

* In Guatemala, most of the localities where the chinch bug has been found lie near the coast. But two are, however, far inland, Pansos being nearly 100 miles from the east coast, while San Geronimo is almost equi-distant from the east and west coasts, and fully twice as far inland as Pansos. As indicating something of the nature of the topography of Guatemala, I have taken the following extracts from "Guatemala, Land of the Quetzal," by Mr. Wm. T. Brigham. (p. 4) A traveler crossing this territory from ocean to ocean would sometimes follow the river valleys, then climb ridges, again traverse a plain, cross a valley, ride along another mountain range, compressing a volcano, and finally descend abruptly to the Pacific. (p. 260.) The tides here (on the Atlantic coast) are less than a foot. (p. 323.) . . . he will readily divide the vegetation into four tolerably distinct regions; these are the shore and river bottoms, the upland and the arid plain. On all the low cayos that are almost awash with every wave, and on the low margin of the main land, extending up the wide rivers for miles, are the mangroves. (p. 369.) On the ridges *Paspalum distichum* grows naturally, on the lowlands and river valleys grass must be planted. (p. 73, speaking of the river below Pansos) There was foam on the water, but we heard no waterfalls,—and indeed the flat nature of the country made falls, cascades, or even rapids, impossible. (p. 5.) In the oceanic valleys and along the coast are the only lowlands in Central America.

Anyone who is familiar with the nature of the country in eastern Texas and Louisiana and understands this plain-loving character of the chinch bug, will appreciate the temptation that would here present itself for the insect to follow the level country inland, as well as along the coast. We have observed how the southern extremity of the Rocky Mountain system divided the current of the northward streams of this insect, owing to its dislike for high elevations, and we now have a second division, not influenced by mountain ranges, but by a fondness for comparatively low and flat areas, not necessarily devoid of trees but furnishing a supply of grass plants sufficient to afford food, which, though not of the exact species found along the coast, yet more abundant and equally suitable for the purposes required by the insects. Thus, I would account for the spread of this species over the country from the south instead of the east, as we have long held to be the case and it seems to me that all its characteristics point to Central America or the extreme northern portion of South America as its original home. It may not be out of place to here call attention to the possibility of some individuals being carried into the Caribbean Sea or the Gulf of Mexico, and through the influence of the Gulf Stream being transported to either Cuba or Florida—a possibility, but not a probability, especially as regarding Florida.

As showing that the route laid down in the foregoing for the chinch bug is not a unique one, but has probably been followed by other species, both before and since, I have chosen as an illustration the Harlequin Cabbage bug, *Murgantia histrionica*, an insect belonging to the same order as *Blissus leucopterus*, but to a different family. With the barely possible exception of its closest ally, *M. munda*, with whose southern distribution I am not familiar, all of the species at all near related to this one are found in Mexico, Central America and the West Indies. Like the chinch bug it is found in Costa Rica, Guatemala and Mexico, extending north on the Pacific coast into California and Nevada. In the east it occurs from Colorado to extreme Southern Illinois and Indiana, and has appeared in Southern Ohio, along the river within the last few years; in fact has only been observed in the locality two or three years. Along the Atlantic, it is found in the latitude of Philadelphia, Pennsylvania. Now, we are able to trace the march of this species from Southeastern Texas, about 300 miles from the mouth of the Rio Grande, where it was first observed in 1864, though it was even then known in Louisiana,

but not elsewhere east of the Rocky Mountains, so that we may safely assume that it entered the United States in extreme southern Texas, precisely as was probably the case with *Blissus leucopterus*. From Washington county, Texas, the species now under consideration spread northward to Denver, Colorado, where it was observed by Mr. Uhler in 1876, and is also recorded the same year from Missouri, by Riley, and also from Delaware. In 1890 it was first noticed in Southern Indiana, and in Ohio as previously stated, and, except in the central portion of the Mississippi Basin now covers the country south of Lat. 40° to the Gulf of Mexico. I may add here also that one of the latest arrivals from Mexico, a Coleopteron *Anthonomus grandis*, has apparently come through this gateway, and has now pushed northward as far at least as San Antonio, Texas. In a paper now in the hands of the Entomological Society of New York, awaiting publication,* I have shown that our entire genus, *Diabrotica*, also coleopterous, probably had its origin in Northern South America, a number of our species having clearly pushed northward from Mexico. So then the route laid down for the chinch bug is by no means a new one.

Finally I wish to call your attention to the fact that I did not start out with the expectation of proving anything, except that *Blissus leucopterus* did not necessarily, originate on the Atlantic coast of the United States and move westward with the progress of grain growing. I cannot claim strict originality, even, as I have used the suggestions of Messrs. Schwarz and Marlatt as a nucleus about which to build. I am simply the first to collect together all the available information, giving my own translation of its meaning when thus brought together. I cannot close without pointing out the rich field of research that lies awaiting the investigator who chooses to take up the subject of the northern spread of South and Central American Insects.

It appears to me as though Mexico and Central America constituted a gigantic, biological cornucopia, that is continually pouring out its wealth of species upon the country to the north. The outline of the two countries does, somewhat, resemble a horn of plenty, and we certainly shall find that a considerable portion of our insect fauna has been evolved from within their boundaries. The dividing line

* Published in vol. iii., pp. 158-166, Journal of the New York Entomological Society, 1895.

between the tropical and what we now term the Lower Sonoran life zones, I have indicated by a heavy black line, (see map). This is the geographical division followed by Lichenstein, Swainson, Erichson, Richardson and Darwin, the latter of whom says that here "the great table land presents an obstacle to the migration of species, by affecting the climate, and forming with the exception of some valleys and of a fringe of lowland on the coast, a broad barrier." It seems that any attempt to pass over this has resulted in specific changes that gave us many of our species, and it is through more stable, generic characters, that we are able to follow much of this considerable portion of our insect fauna to its ancient habitat. LeConte, in his map showing the Entomological Provinces of North America, has shown that a portion of the tropical zone covers the coast area of southern and southeastern Texas, while the maps of Packard and Merriam indicate the dividing line in Mexico much more clearly. The chinch bug now covers, approximately, the eastern division of the United States as indicated on the map of LeConte, as published in 1859 by the Smithsonian Institution.

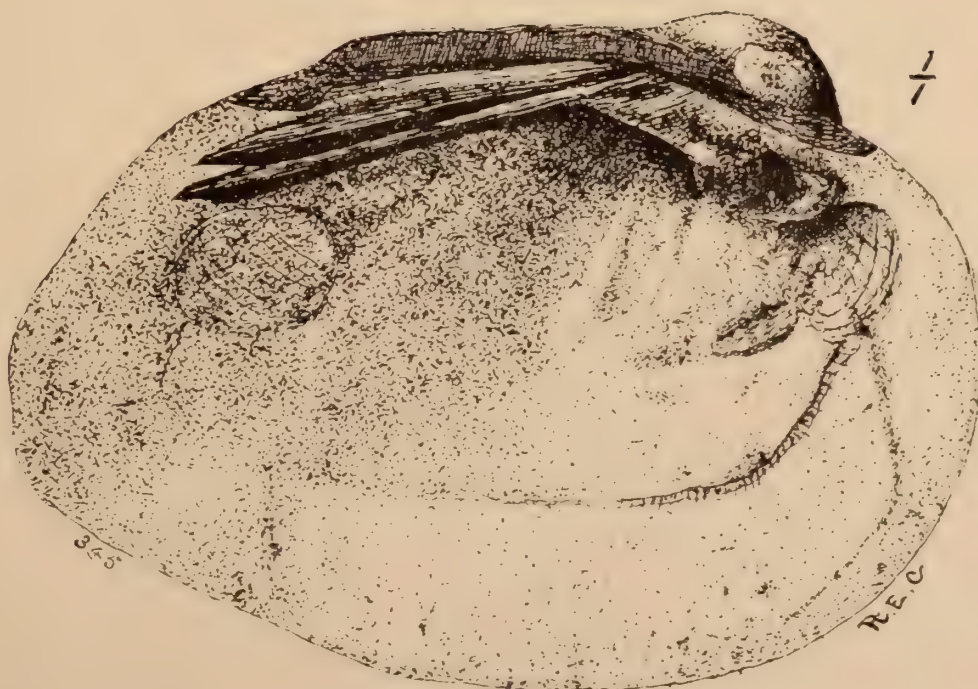
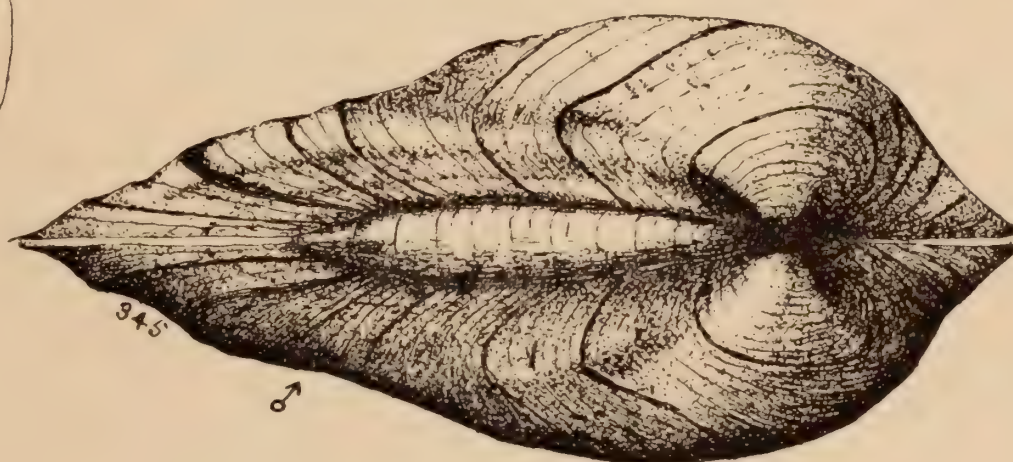
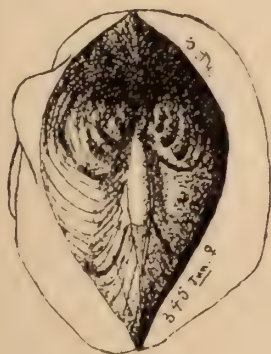
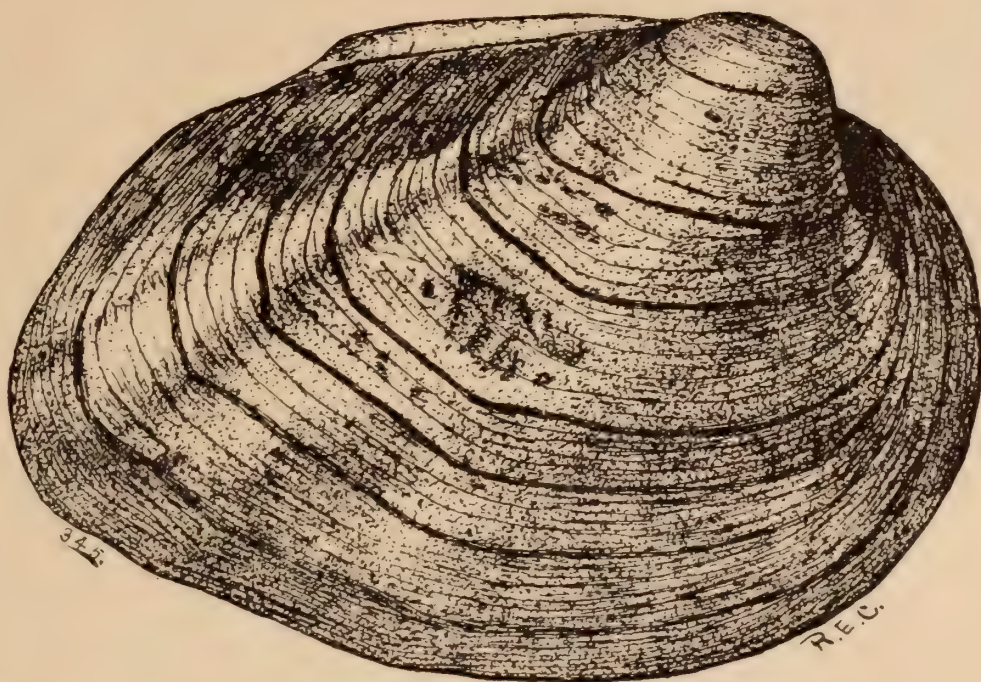
Mr. L. O. Howard, United States' Entomologist, has kindly aided me in looking up the references in *Biologia Centrali-Americana*, a work to which I did not have access; and for the present distribution of this species in North America, I am indebted for information to Mr. James Fletcher, Entomologist of the Dominion of Canada, Profs. Luggier of Minnesota, Brunert of Nebraska, Gillette of Colorado, Neal* of Oklahoma and Cockerell of New Mexico.

Since the above paper was presented, Mr. John R. Chandler, State Archæologist of Guatemala, Central America, has kindly given me the locations and elevations of the localities where *Blissus leucopterus* is recorded as occurring in that county by Mr. Champion. (*Biologia Centrali-Americana*, vol. I, p. 196.)

SAN GERONIMO, interior,	elevation about 3,000 feet.
PASO ANTONIO, ?	?
PANZOS, low, near river emptying into the Atlantic,	elevation about 2,000 feet.
CHAMPERICO, Pacific coast,	elevation sea-level.
RIO NARANJO, near Pacific coast,	elevation about 2,000 feet.

F. M. W.

*Lately deceased.



ILLUSTRATIONS OF LITTLE KNOWN UNIONIDÆ.

BY R. ELLSWORTH CALL.

I. UNIO ÆSOPUS, Green.*

Plate VI.

In 1827 Dr. Jacob Green obtained from "the rivers in the neighborhood of Pittsburg" an undescribed *Unio* to which he gave, with formal description, in Contributions of the Maclurian Lyceum to the Arts and Sciences, I. p. 45, July, the name *Unio æsopus*. Later investigations developed the wide distribution in the rivers of the west of this shell; but its original description is so rarely seen that nearly all modern identifications are traditionary. Frequently this highly characteristic shell is received from collectors under the various names of *Unio rubiginosus* Lea, *Unio coccineus* Lea, and occasionally with specimens of *Unio ellipsis* Lea. The plate which Dr. Green designed to illustrate this species is a rather poor specimen of early lithographing and does not well exhibit its characters; the male shell was employed.

* Jacob Green, M. D., was born in Philadelphia on the 26th of July, 1790; he died in that city on February 1st, 1841. He was well and favorably known as an educator and was for a number of years professor of chemistry in the Jefferson Medical College. His scientific work was not extensive but was of a most excellent character. He was a distinguished student of mollusca and of trilobites. He was the discoverer of that small but most interesting form from the Utica Shale known as *Triarthrus beckii*.

The original description was as follows :

“ Testa ovata, antice undato angulata, compressa, postice orbiculata, transversim sulcata et rugosa; rugis prope margines obsoletis, serie nodulorum a natibus versus margines, inferiorem decurrente, instructis; natibus decorticatis et leviter erosis; periostracha nitida, luteo fusca; intus alba iridescente; dentibus crassis, striatis. Plate 3.

“ Hunched Unio. — Shell oval-compressed, thin and slightly angular at the anterior end or margin, regularly rounded, convex and thick at the posterior margin, slightly incurved and but little eroded, from the beaks over the disk and near the middle of the shell there is a remarkable gibbosity or nodulous ridge, produced by the striæ becoming in this place remarkably thick and tuberculated. There appears also in some specimens the indications of a second ridge near the anterior end; both these ridges are alternately raised and depressed; periostracha much wrinkled by the striæ, of a light horn color, and remarkably glabrous, in old and young specimens, it is darker than the perfect shell, and the young are often beautifully rayed and spotted with brown; nacre commonly white, pearly and iridescent; teeth moderately thick, length about two inches, breadth about four.

“ This shell inhabits probably all the western waters; and it is a little remarkable that Prof. Rafinesque, who has described and figured so many of the Unionidæ, should have omitted this remarkable species. I found eight or ten of these shells in the river in the neighborhood of Pittsburg. In old shells the anterior margin is often produced and truncated, and the young specimens seem to be peculiarly liable to a preternatural enlargement of some portions of the shell more than others.”

Seven years prior to this description Prof. Rafinesque had described a shell from the Falls of the Ohio River, at Louisville, Kentucky, where *Unio æsopus* is a common form, to which he gave the name *Obliquaria cyphya** and which he has characterized as follows:

“ 29. Espèce. *Obliquaria cyphya* (*Unio cyphia*.) *Oblique cyphie*.

“ Test épais bombé, bosselé, bord flexueux, en talus postérieurement; épiderme brun-châtain; tubercule à rides flexueuses; nacre blanche. Longueur 8-9, diamètre et axe 5-9 de la largeur.

* *Vide*: Annales Générales des Sciences Physiques, Bruxelles, Septembre 1820. Page 305.

“ Largeur 2 à 3 pouces ; test plus épais antérieurement, à grosses rides et à quelques tubercules oblongs ; une grosse bosse oblique longitudinale ; dents épaisses striées. Aux chutes de l’Ohio.”

Rafinesque did not attempt to figure this species, as he had done with most of the shells described in his memoir. In the absence of a good figure only his technically imperfect and brief description may be relied on to furnish a clue to the shell he intended in this case. There has never been much question in my mind that he had *Unio æsopus* before him when he made his diagnosis. No other Ohio River *Unio* could possibly satisfy the characters here given. The single character of “chestnut brown epidermis” alone is not true of most specimens of this form, but such examples are often found. The original description is here repeated that the reader may himself decide whether a careful review of the species will not credit the form to Rafinesque.

In pursuance of the objects of this series of papers a new description is here given, based upon recent and well-preserved specimens from the Ohio. The plate given is based upon a specimen from the Des Moines River, Iowa, and is of a full-grown male and a young female.

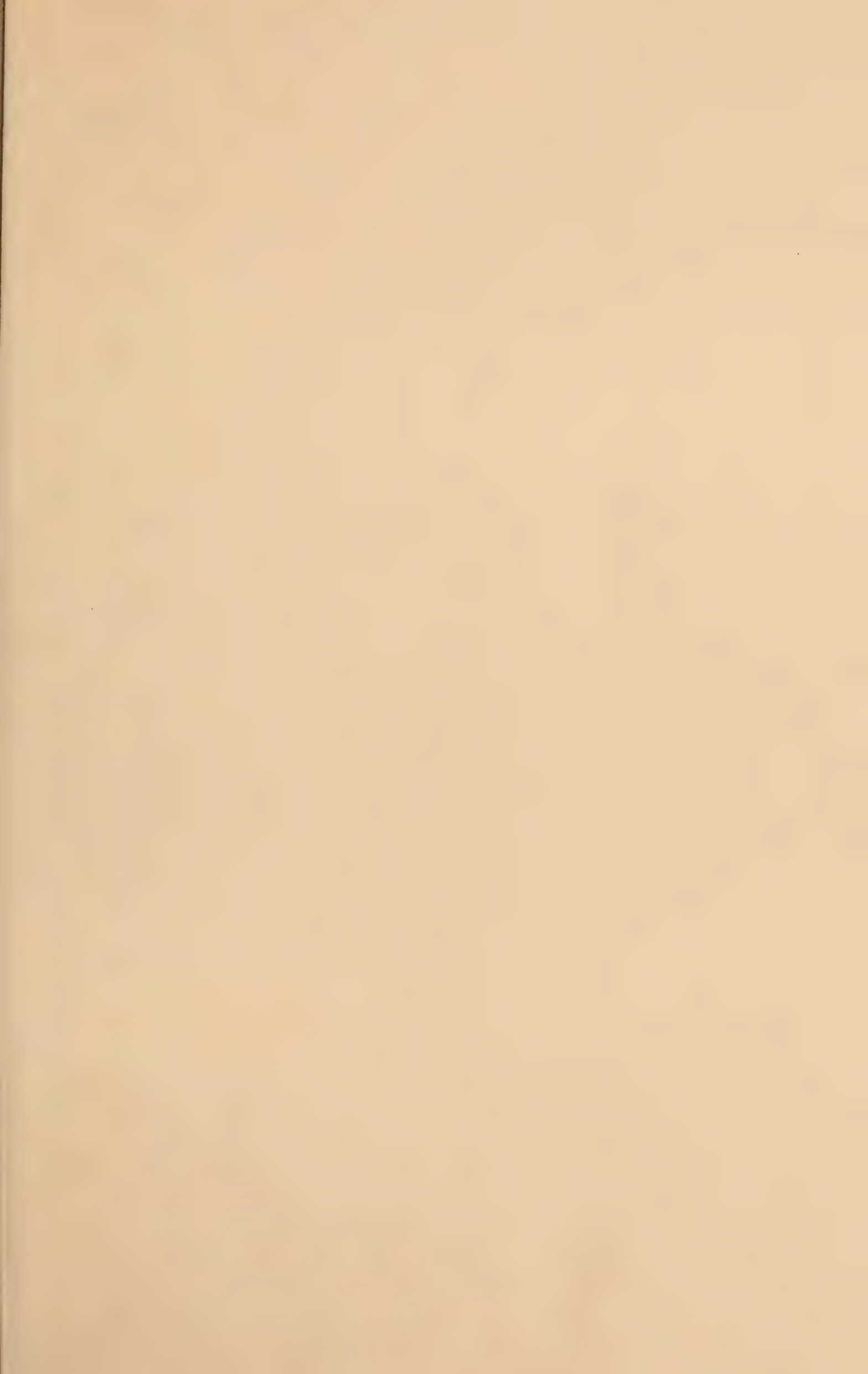
Unio Æsopus, Green. (Descriptio emend.)

Shell sub-oval, somewhat flattened laterally, incrassate anteriorly, thinner over posterior region, obscurely tuberculate from middle of umbonal slope to ventral margin, the obtuse tubercles being alternately disposed and usually largest about the middle of the disk ; the anterior margin is regularly rounded as far as the region of the umbonal tubercles, then usually emarginate or sulcate, a character which is particularly well marked in the old female and the very young ; growth striæ numerous, crowded, and conspicuous, the lines indicating arrest of growth being darker and broader, well marked and rather deeply impressed ; ligament light brown, smooth and flat-elliptical ; lunule evident and somewhat cordate ; the beaks are coarsely and concentrically undulate, the undulations numbering three or four, with the epidermis somewhat lighter in color than that on the slopes of the umbones ; cardinal teeth single in the right, and double in the left valve, triangularly pyramidal ; lateral teeth lateral in the left, and disposed to be double in the right valve, nearly or quite straight in old specimens, or slightly curved downward in the very young shell, thick ; anterior cicatrices distinct, pit-like and deeply impressed ; pos-

terior cicatrices distinct, well impressed, that of the *retractor pedis* being more distinctly marked than the *posterior adductor*, and impressed at end of lateral teeth; pallial cicatrix faintly impressed and somewhat sinuous; cavity of the beaks shallow and rounded, with numerous, linear, minute muscular impressions posterior to the base of the cardinals and often upon them; epidermis straw yellow or honey brown in color, the young specimens occasionally found with hair-like green rays which are, however, confined to the umbonal slope; nacre pure white and somewhat iridescent posteriorly.

Geographical distribution.—This shell ranges from western Pennsylvania to the Alabama river, Alabama and westward to Iowa and Minnesota. In the rivers of the middle Ohio drainage and in Iowa it is a common and beautiful species. The animal is of a deep salmon color, which character should assist in separating it from its congeners.

Cincinnati, January 26, 1896.



AN ACCOUNT OF THE MIDDLE SILURIAN ROCKS OF
OHIO AND INDIANA,

Including the Niagara, and Ohio Clinton and the bed at the top
of the Lower Silurian strata, formerly considered the Medina.

(With a Map; Pl. VII.)

BY AUG. F. FOERSTE.

CONTENTS.

A. THE BELFAST BED OF OHIO, FORMERLY CALLED THE MEDINA,
WITH FREQUENT OBSERVATIONS ON THE "CLINTON" OF OHIO.

- I. *A general discussion of the problem, with the conclusions derived from
a study of the same.*
- II. *Description of observations at the separate localities.*

1. Winchester.
2. Peebles.
3. Kelly's Mill.
4. Belfast.
5. Sharpsville.
6. Todd's Fork.
7. Spring Hill.
8. Betty Heidy's Quarry.
9. Cæsar's Creek.
10. Goe's Station.
11. Donnelsville.
12. Brown's Quarry.
13. Morris Hill.
14. Marian Clark Farm.
15. Thorp Farm.

16. Centreville.
17. Huston's Quarry.
18. Fauver's Quarry.
19. Keplinger Farm.
20. West Charleston Falls.
- 20a. John Cushwa's Farm.
21. Col. Woodward's Farm.
22. Troy. High Banks.
23. Piqua.
24. Ludlow Falls.
25. West Milton.
26. New Paris.
27. Euphemia.
28. Lewisburgh.
29. Carl Quarry.
30. Crisman Quarry.
31. Eaton.
32. Eaton. Clinton Quarry.
33. Enterprise Quarry.
34. Fair Haven Quarries.

B. A STUDY OF A PORTION OF THE UPPER SILURIAN ROCKS OF SOUTH-EASTERN INDIANA AND THEIR CORRELATION WITH EQUIVALENT STRATA IN OHIO.

I. *A general discussion of the problem, with the conclusions derived from the study of the same.*

II. *Description of observations at the separate localities.*

35. Richmond.
36. Elkhorn Falls.
37. Longwood. *a.* Ball's Quarry.
b. Washam's Quarry.
38. Laurel. *a.* Dry Branch Quarry.
b. Henry Dice's Quarry.
c. Seegar's Quarry.
d. Chris Meade Falls Quarry.
e. Derbyshire Falls.
39. New Point.
40. Rofing and Wagner's School House.
41. Napoleon.
42. Osgood.

A. *The Belfast bed of Ohio, formerly called the Medina, with frequent observations on the Clinton of Ohio.*

The Clinton formation of Ohio is the lowest formation in that state, belonging without question to the Upper Silurian. Between the Clinton of Ohio and the upper fossiliferous beds of the Cincinnati formation occur in many parts of the state a series of unfossiliferous beds which it is difficult to assign definitely either to the Upper or to the Lower Silurian. Quite frequently the upper part of these unfossiliferous beds consist of a firm rock breaking up and becoming shaly parted after being exposed for a time to the influences of weathering. Where fresh it has a bluish color, but where long exposed it is yellowish or brownish. It has a massive structure in places, being made up of layers 4 to 12 inches thick, with thin partings. Containing in addition to lime a considerable amount of argillaceous material, it is in strong contrast with the very pure Clinton limestones, which overlie it. It is usually underlaid by blue clay or clay with shaly partings. It is therefore, where typically developed, a horizon easily recognized. Its typical development is beneath the eastern line of outcrops of the Clinton in Ohio. It occurs for instance two miles south of Winchester, at Kelly's Mill on Branch creek, about three and one-half miles southeast of Belfast, at numerous points near Belfast, at Sharpsville, at Todd's Fork north of Wilmington, at Spring Hill, 6½ miles west of the Todd's Fork locality, at Betty Heidy's quarry, 5½ miles west of the Spring Hill locality and east of Oregonia, at Cæsar's creek, 4½ miles south of Xenia, at Goe's Station, 3½ miles southeast of Cedarville, and at Donnelsville, 9 miles west of Springfield. Along this eastern line of typical exposures few fossils have been found. Annelid teeth have been noted at the various exposures near Belfast, at Sharpsville and along Todd's Fork. At Sharpsville was found a species of *Orthis* allied to the form which I have described under the name *O. calligramma* in my papers on Clinton Group fossils. The valves show however a greater number of plications and other variations, which for the present make the fossil useless for purposes of correlation. At the bridge exposure southeast of Belfast there was found an undoubted specimen of *Halysites catenulatus*. This species has never been recorded from the undoubted Cincinnati group in this state, Indiana or Kentucky. It is on the contrary a fairly common fossil in the so-called Clinton, immediately above. The occurrence of *Halysites* is therefore strongly suggestive of the Upper Silurian age of this rock, and it is

the only fossil suggesting such affinities. On account of the many good exposures of this argillaceous limestone formation near Belfast, in Highland County, Ohio, it is called here the *Belfast bed*. Its usual thickness is between 3 and 6 feet.

West of its eastern line of outcrop, the Belfast formation does not maintain the same characteristic structure. If it is represented at Morris Hill, half a mile northeast of Dodd's Station, it is only in the form of a brownish shaly stone. On the Marian Clark farm, about half a mile west of Lytle, a layer similar to the Belfast bed, but only 7 inches thick, is overlaid by 12 inches of blue clay, and underlaid by 15 inches of the same material. On the Thorp farm, two miles northwest of Waynesville, and two miles directly east of Lytle, the Clinton is underlaid by about 3 feet and a half of blue clay in the gully, and is represented by fine, fissile, brownish shale in a side branch nearer the barn. At Centreville the Clinton is underlaid by about 30 inches of a firm blue massive rock, finer grained than the usual Belfast rock. At Huston's quarry the Clinton is underlaid by about $6\frac{1}{2}$ feet of brown shales, rather firm and sandy, hardly clayey. At the Soldiers' Home quarries there is no rock underlying the Clinton in anyway corresponding to the Belfast bed, unless it be a clay layer containing *Orthis occidentalis*. At Fauver's quarry, about two and a half miles north of Dayton, about 22 inches of shaly blue clay and 20 inches of hardened blue clay underlie the Clinton. On the Keplinger farm, about half a mile east of Tadmor, about 24 inches of fairly solid, massive, greenish blue rock underlying the Clinton represent the Belfast bed. In the Charlestown Falls section, 42 inches of a rather firm blue rock, massive, in thick courses, represent the Belfast bed. They are underlaid by 34 inches of thinner, more shaly rock, and then by 9 inches of limestone, presumably Lower Silurian. At the High Banks, 3 miles south of Troy, $6\frac{2}{3}$ feet of a light brown rock are found beneath the Clinton. It occurs in layers $2\frac{1}{2}$ and 3 inches thick, frequently traversed by vertical cracks, and more firm than the shales beneath.

West of the line of outcrop of the typical Belfast bed this bed is therefore represented by rock having somewhat different lithological characteristics. These differences are well marked towards the southwest where shales or even blue clays seem to represent this horizon in many localities. They are less marked in the intermediate regions from Dayton northward, where the corresponding rock is firmer, in contrast with the more frequently parted softer shaly rock beneath.

The more western series of outcrops of the Belfast bed horizon, has not furnished fossils, but in the intermediate region at High Banks, south of Troy, annelid teeth were found in the upper courses of the shales below the Belfast bed.

The question arises, what do the annelid teeth indicate concerning the age of the Belfast bed? The same species of annelid teeth as those found in the Belfast bed occur also in the undoubted Lower Silurian limestones, at the railroad bridge three miles west of Peebles, where the Belfast bed is entirely absent. They occur also near the top of the underlying shales at the High Banks, which twelve feet farther down, and again three feet lower, include limestone courses of undoubted Lower Silurian age. These occurrences suggest the Lower Silurian age of the annelid teeth, and hence of the Belfast bed.

The presence of *Halysites catenulatus* therefore suggests an Upper Silurian horizon, and the presence of the annelid teeth, a Lower Silurian horizon.

The next question which suggests itself is, what evidence of Upper or Lower Silurian origin can be secured by closer observation of the lithological features of the Belfast bed. The exposures of the rocks below the Clinton, along the western exposures in Ohio are quite instructive in this direction. At Ludlow Falls, under the Clinton are found two and a third feet of blue, argillaceous, but quite firm stone, in layers usually two to three inches thick. This is the Belfast bed. Below it are five feet of a softer, more clayey blue shale. At West Milton the material immediately beneath the Clinton is a blue clay with shaly partings, 58 inches thick; then 8 inches of a hardened blue clay comparable to the Belfast bed in the intermediate series of exposures, west of the more eastern line of outcrops; beneath are 62 inches of blue shaley clay in the lower two feet of which occur Lower Silurian forms of *Orthis* (*Platystrophia*) *biforata*, with fairly broad plications. At Lewisburg, along the creek about half a mile south of town the Clinton is underlaid immediately by a three inch course of hard blue limestone with *Orthis occidentalis* and many branching Lower Silurian bryozoans; next come about three feet of blue clayey shale beneath which are 4 inches of limestone. Near Enterprise the Clinton is underlaid by 12 inches of greenish clay, below which occur limestone fragments with *Orthis biforata*, *Orthis occidentalis* and *Tetradium*. About two miles south

of Eaton, the Clinton is underlaid by at least three feet of a greenish blue shaly rock. A small specimen of *Tetradium* was found within a foot of the base of the Clinton, thus showing the lower Silurian character of the shale. At Fair Haven the Clinton is underlaid by about eight inches of finely stratified, bluish white, hard rock.

In this western series of exposures the most noteworthy fact is the occurrence at several localities of blue clay at the horizon of the Belfast bed. Still more important for purposes of correlation is the occurrence in the lower parts of these clays at West Milton and Enterprise of Lower Silurian fossils, while Lower Silurian fossils occurred in the shales south of Eaton and in limestone at the very top of the blue clayey shales at Lewisburg and at Fair Haven just beneath the Clinton. When, therefore, the Belfast bed is followed around the northern margin of its area of outcrops to the western outcrops in Ohio, it is found in the western sections to contain Lower Silurian fossils.

Another feature appears to speak strongly for the Lower Silurian character of the Belfast bed, and that is that it in many exposures is underlaid by a softer, more clayey shale, and this in turn by blue clay, and that either in the shale or in the blue clay undoubted Lower Silurian fossils occur; moreover it is manifest that above these fossiliferous layers the clayey beds are becoming firmer and more massive, without any time break being indicated in any way until the Clinton is reached, so that the Belfast bed must be considered a part of the Lower Silurian, in spite of the occurrence of the *Halysites catenulatus*, at least until more satisfactory evidence of its Upper Silurian character can be produced than is possible at present. It is certain that in following the undoubted Belfast bed westward, it merges into more clayey beds which in certain localities are undoubtedly Lower Silurian.

The occurrence of *Halysites catenulatus* under these circumstances is interesting. It is an early forerunner of the Upper Silurian in rocks still Lower Silurian. Migration of ocean faunas must have been one method by means of which various horizons have come into existence. The new faunas could hardly have always been the result of developments *in situ*. In fact, the more abrupt the change of fauna to fauna, the more imperative the supposition that immigrations of faunas had taken place, while development of new types of faunal life *in situ* should make a demarkation of horizons much more difficult. See in this connection page 397 of Proc. of Boston Soc. Nat. Hist. for May 1, 1889.

1. *Winchester*.—About two miles south of Winchester on the farms of Clinton Masters and W. T. Carson, are exposures of Upper Silurian rocks. On the east side of the road just south of a very small stream the Dayton limestone is exposed. It is yellowish in color and not very firm, but it comes out in regular courses and is therefore quarried. Immediately beneath occurs the Clinton, containing *Calymene vogdesi*, large form, *Orthis* (*Herbertella*) *daytonensis*, well defined, both valves, *Orthis* (*Platystrophia*) *biforata*, *Orthis* (*Dalmanella*) *elegantula*, *Heliolites megastoma*?, *Favosites niagarensis*, *Halysites catenulatus*, and *Ptychophyllum ipomæa*. On the west side of the road, the middle and lower parts of the Clinton are exposed in the bed of the stream, the total thickness of the Clinton being estimated at about thirty feet. The lower part of the Clinton is a reddish crinoidal rock. Immediately beneath occurs a bluish rock, the Belfast bed. Unfortunately the thickness of this bed was not recorded, but it was about four or five feet thick. Beneath it occurred blue clay, and, lower down, the limestones of the undoubted Cincinnati formation.

2. *Peebles*.—The ripple marks in the Springfield rock, about a quarter of a mile west of Peebles, along the railroad, occur at a level of at least thirty feet above the Niagara shales. The shales are at least 40 feet thick. Underneath them occurs a rubble-stone. The top of the Dayton limestone lies 45 feet beneath the shale. The Dayton limestone has a thickness of three feet. The Clinton seems to be 40 feet thick. There is no stone corresponding to that elsewhere found beneath the Clinton in this part of the state, called the Belfast bed. The Cincinnati rock immediately beneath the Clinton contains however the same annelid teeth found elsewhere in the Belfast bed. The rubble stone above mentioned corresponds in a general way to the brownish or bluish rock which occurs elsewhere in well defined layers above the Dayton limestone, but which is unsuitable for building purposes on account of its ready deterioration and breaking up under the influences of weathering.

3. *Kelly's Mill*.—About three and a half miles southeast of Belfast, on the road to Loudon, where it crosses Brush creek, occur exposures of the Belfast bed. The best of these is on the northside of the creek along the west side of the road. The Belfast bed is here 72 inches thick. It is overlaid by a few inches of Clinton limestone.

Beneath are five to six feet of bluish and brownish shales. On the south side of the creek the Belfast bed is shown again. Above it there is a greater exposure of the Clinton, showing near the top some of the very characteristic fossils of that formation.

4. *Belfast*. — The sections near Belfast are sufficiently well described in a paper on "*Clinton Conglomerates and Wave Marks in Ohio and Kentucky*," Journal of Geology, Vol. III, No. 2. At the bridge exposure southeast of Belfast, the Belfast bed is well exposed and contains *Halysites catenulatus* and annelid teeth. It is also well exposed farther up stream, above the bridge southwest of town, on the J. V. D. Smart farm, and again on the William Haigh farm along a small stream emptying into Brush creek from the north. In the William Haigh farm section the conglomerate layer in the ferruginous part of the Clinton lies only 15 inches below the Dayton limestone. The layer with stratification line dipping 25 degrees southward is at least 13 feet below the level of the Dayton limestone. That part of the section opposite the barn containing a stray blue pebble one inch in diameter is at least 15 feet below the Dayton stone. The fossils opposite the house occurred in a bed at least twenty-three feet below the Dayton stone. The upper flinty layer occurred about 32 feet below, and the lower one about 34 feet below the Dayton stone. The base of the Clinton was 38 feet below the base of the Dayton, this being the total thickness of the Clinton. The pebbles are not confined to the top of the Clinton in this section but occur also in the middle, although of smaller size. The bottom layers of the Clinton contain *Plectambonites transversalis*, var. *elegantula*. The Belfast rock is here 4 feet thick, and contains annelid teeth. Beneath occur 22 inches of a bluish clayey material with shaly partings.

Going north from Belfast to Hillsborough, the postoffice at Berryville is found to be about 208 feet above the level of the Dayton stone near Belfast. The highest point north of Berryville is 48 feet higher up. The base of the Dayton stone at Rocky Fork, a mile and a half south of Hillsborough, is according to a single barometer reading about 60 feet above the level of the Dayton limestone near Belfast. At several points along the road between Belfast and Hillsborough, lime-sinks occur. They are not deep and serve in several places as hog-wallows. Their elevation is about 150 feet above the base of the Dayton limestone.

5. *Sharpsville*.—This section is described in the paper on Clinton conglomerates, above mentioned. The total thickness of the Clinton is about twenty-seven or thirty feet, judging by means of the barometer. The lowest pebble was found a short distance east of the entrance of the small stream from the Alexander farm into the creek, at an elevation of about 14 feet above the base of the Clinton. The pebble measured 20 by 9 inches; it was a piece of chert such as is found in the basal Clinton, and contained *Calymene vogdesi*, *Phacops trisulcatus* a pygidium with 4 lateral pleurae, *Orthis* (*Platystrophia*) *biforata*, large form, *Orthis* (*Dalmanella*) *elegantula*, and *Rhynchonella acinus*, var. *convexa*. The bedding of the Clinton is strongly marked here and also farther up the creek, but it is uneven. Good pebbles, 4 by 1½ by 3 inches are found farther up the creek, about 18 feet above the base of the Clinton. The pebbles here were composed of the bluer, finer grained Clinton. Going northward up the small stream the bedded Clinton is found 11 feet above the base of the Clinton, and the Clinton conglomerate is found 18 feet above the base of the Clinton. The Clinton conglomerate at the east and west fence is found about six to 8 feet higher up. The upper Clinton at this point does not show pebbles, being reddish crinoidal, turning at the top into a dark red sandy rock containing *Rhynchonella acinus* var. *convexa*. This fossil is shown for instance along the west side of the stream just south of the line of barns on the Sharp farm. The thickness of the Belfast bed in the creek bed opposite Sharpsville is about 4 feet. In addition to annelid teeth, a species of *Orthis*, a little on type of *Orthis calligramma*, with 44 plications, was found. The barometer reading placed the top of the Clinton at the creek exposure southeast of Farmer's Station at a level about 15 feet below that at Alexander's quarry in the Sharpsville section.

6. *Todd's Fork*.—Where the Xenia pike crosses Todd's Fork, about three miles north of Wilmington, the base of the Dayton limestone is well exposed. Underneath lies the more or less ferruginous Clinton. A deeply red layer with small oolitic iron grains occurs about 5 feet below the Dayton stone, and contains a new species of *Craniella*. The pebbles found almost opposite the Miar house farther down stream occur about 10 feet below the Dayton limestone. The total thickness of the Clinton is about 35 feet. The Belfast bed here has a thickness of 5 feet, and contains annelid teeth. About two feet

lower down is seen the top of the blue clay layer, and blue clay is found down to the level of the creek bed, about fifteen feet lower down.

7. *Spring Hill*—also known as Wilkerson's Hill; on the pike from Wilmington to Lebanon, about $6\frac{1}{2}$ miles a little south of west of the Todd's Fork locality. At the east end of this hill, where the pike rises from the low lands formed by the Cincinnati group to the upper level formed by the hill or ridge, the Clinton is exposed at the way-side. About 10 feet of the lower half of the group is seen. It is identical in character with the lower Clinton at Todd's Fork; it has a pinkish color, is composed of a great quantity of crinoidal fragments, chiefly pieces of small crinoid stems and the materials show bedding, with at times a sort of cross bedding. The upper Clinton is not exposed. Almost facing this exposure is the house of J. H. Vandervoort. Behind his house the Clinton is seen to overlie the Belfast bed, this formation having here a thickness of about five feet. Underneath are at least three feet of a light blue clay. The lower Clinton and the Belfast bed are again well seen in the excavations or quarries along the edge of the woods one-eighth of a mile farther north, down the farm lane. At the roadside the Clinton contains *Encrinurus punctatus*, pygidium, *Phylloporina angulata*, *Hemitrypa ulrichi*, *Halysites catenulatus*, *Favosites niagarensis*. Fossils were scarce. The Belfast bed here has a light, yellowish brown color, this color being probably the result of weathering, the original blue having been altered under the influences of long exposure.

8. *Betty Heidy's Quarry*—about half way along the road leading from the Olivé Branch School District No. 2 (on the Wilmington and Lebanon Pike) to Oregonia and about $5\frac{1}{2}$ miles west of the Spring Hill locality. At this point is found a large slab of Clinton rock, said by Prof. Orton, on page 385, volume III, of the Ohio Geological Survey, to be about 16 feet thick, to have an extent of three fourths of an acre, and to occur 125 feet below the proper horizon for the Clinton. The present worker of the quarry estimates the area covered by the slab at about 3 acres. The Clinton is pinkish in color, and is made up of small crinoidal fragments, similar to the lower two thirds of the Clinton section at Todd's Fork and to the Clinton in Spring Hill; like it, also, it is practically destitute of other fossils. At the top of the Clinton several inches of rock similar to

the purplish sandy layers seen at the top of the Clinton at Todd's Fork are seen. Under the Clinton is the Belfast bed; it has the same light yellowish brown color as at Spring Hill, though bluish tints are also seen. Its thickness is between four and a half and five feet. The blue clay layer beneath was not seen. It was probably the weak resistance of this blue clay layer which gave the glaciers a chance to loosen the slab and to bring it from a short distance to this point. I did not observe any gravel under the Belfast bed anywhere but the slab is evidently out of place, and at present is much crumbled. The chief interest of the slab lies in the presence beneath it of the Belfast bed in its full thickness.

9. *Caesar's Creek*—four and a half miles south of Xenia, where the Xenia and Wilmington pike crosses Caesar's Creek. Numerous exposures occur on the northern side of the creek, a short distance east of the pike. Only the lower six feet of the Clinton are here exposed. It is chiefly crinoidal but contains also phases similar to the denser white rock of the Clinton at Soldiers' Home. The latter is usually abundantly fossiliferous, and the following forms were found: *Illæus daytonensis*, *Illæus ambiguus*, *Calymene vogdesi*, large form, glabella, *Lichas breviceps*, *Leptaena rhomboidalis*, *Strophomena tenuis*, *Strophomena patenta*, *Orthis calligramma*, the large Soldiers' Home form, *Meristella umbonata*, *Atrypa marginalis*, common, *Ptilodictya lanceolata*, var *americana*, and probably also *Ptilodictya whitfieldi*, *Clathropora frondosa*, common, *Phænopora expansa*, *Phænopora magna*, *Pachydictya bifurcata*, *Pachydictya obesa*, of which *P. turgida* is probably only the more branching form, *Rhinopora verrucosa*, *Hemitrypa ulrichi*, *Phylloporina angulata*, *Favosites niagarensis* and *Halysites catenulatus*.

Under the Clinton lie about five feet of the typical Belfast bed. Its color is bluish when fresh, but long weathering has made most of the rock at this exposure brownish in color. The only fossils recognized in it were fucoidal markings, and casts of crinoid stems, the lime having leached out. Below this for about six feet there is no exposure. Under this in the bank of the stream are six feet of a shaly material, being brownish at the top, and bluish and more clayey farther down. At its base is a firmer course, about 8 inches thick, resembling the Belfast bed in texture. Below it there is a purplish clay, shaly parted, at times mottled with blue. It will be noted that no recognizable fossils were found in that part of the

section below the Clinton. The bluish shaly clay below the Belfast bed undoubtedly corresponds to the blue clay bed found at a similar horizon along Todd's Fork, west of the Belfast bed exposure, a considerable distance down stream. It probably also corresponds to the blue clay bed at the base of the section on Morris' Hill, east of Dodd's Station, and to the brownish shales immediately overlying the same.

10. *Goe's Station*—three and a half miles south of Yellow Springs. West of the station, up a ravine behind the farm house of Mr. Goe, a considerable thickness of Clinton is well exposed. It is chiefly crinoidal, and is stained reddish or brown by iron compounds. Few fossils were found here. Including those found in the same horizon as far northwards as Yellow Springs, the following is the list: *Favosites favosideus*, *Favosites venustus*, with cells 1 mm. and less in diameter, *Halysites catenulatus*, *Diphyphyllum caespitosum*, *Cyathophyllum calicula*, *Chonophyllum niagarensis*, *Phylloporina angulata*, *Hemitrypa ulrichi*, *Orthis biforata*, var. *daytonensis* and *Illænus daytonensis*.

Immediately beneath the Clinton occurred a fine grained, light brown rock, more bluish where fresher, inclined to be massive in some of its courses. This rock attains here an aggregate thickness of seven feet. It is the Belfast bed of more southern sections. It is more inclined to show shaly courses than the more massive representatives farther south. Beneath are nine feet of thin, light brown shales. Below this the section was not measured. First there comes one foot of a light blue clayey material, then at least six feet, which are unknown, but which at another point, not far south, seems to contain some brownish rubbly rock. Below this are at least eight feet of clay, of a bluish color, frequently mottled however with reddish and purple. This completes the section in the ravine, but farther southwest, along the hill side, it becomes evident that perhaps twelve feet of light brown shale intervened between the clay and the fossiliferous Cincinnati limestone beneath.

11. *Donnelsville*—nine miles west of Springfield, on the railroad to Troy. An eighth of a mile east of the station, on the hillside north of the pike, the Clinton is well exposed. Its color is here pinkish or even rose colored. The rock is very hard, apparently siliceous, and contains few fossils, even the crinoid stems are often represented only by casts. Underlying the same is the typical Belfast bed, a fine

grained brownish massive rock, inclined to break up into shaly fragments. Its color was undoubtedly bluish before weathering. It is difficult to determine here the line of demarkation between the Clinton and the Belfast bed, since the transition, whether owing to the decay of the lower Clinton or otherwise, is not sufficiently abrupt. The Belfast bed varies therefore between five and eight feet in thickness, according to where the dividing line is placed.

The same siliceous Clinton is found west of the water tank, about two-thirds of a mile west of Durbin, along the same railroad, and also, half a mile southwest from the latter locality, at Snyder's Station, on the south side of the river, along the railroad. The Belfast bed was not found here. A blue clay capped by limestone is reported in the woods, three-quarters of a mile southeast of Snyder's Station, but apparently at a higher level. This would be a very anomalous occurrence and deserves investigation. Since not seen by the writer, no opinions upon it can be expressed here.

12. *Brown's Quarry*—half a mile south of Brown's Station, and two and a half miles west of New Carlisle. Here only the upper eight or ten feet of the Clinton are to be seen. It is almost a pure limestone, white in color, and on weathered surfaces reveals a sort of cross-bedded structure. *Favosites niagarensis*, with 5 tubes in 10 m m., occurs here in hemispherical masses, the largest reaching a height of 17 and a width of 35 cm. *Diphyphyllum caespitosum* exists here in masses, reaching a height of 47 and a width of 57 cm. About ten or twelve feet beneath the top of the Clinton the rock is reddish and has been worked into finely polished slabs under the name of marble. Beneath this are said to occur about 18 feet of a light buff rock, not seen by the writer, under which is a blue shaly rock. If the buff rock be included with the Clinton, the bluish shaly rock is then possibly the Belfast bed. The workmen descended only one foot into this layer.

13. *Morris Hill*—half a mile northeast of Dodd's Station, on the Dayton, Lebanon and Cincinnati railroad. The sections on the north and south of Morris Hill along the road crossing the same, do not agree exactly. Along the highest part of the road about seven feet of coarsely crinoidal Clinton limestone are exposed. It is weathered to a brownish color and contains few fossils.

West of the road more of the Clinton is exposed in the higher ground in the orchard. The top of the Clinton is not shown, having been removed by erosion. Beneath the Clinton on the south side of the hill there is a brownish shaly stone. Though corresponding in position with the Belfast bed, it does not agree with it lithologically, the Belfast bed being usually more massive and united into thicker layers, and not inclined to be shaly. Moreover only 15 inches of these shales are exposed while the Belfast bed is usually four or five feet thick. On the north side of the hill, beneath the level of these shales, and 4 feet beneath the level of the Clinton, occur two feet of thin limestone layers, containing small Lower Silurian bryozoans. Below are two feet of heavier limestone courses with *Orthis occidentalis* fairly abundant. Below the limestones are 4 feet of clay mottled with green and purple, and then two feet of brownish, fine, fissile shales. Then occur perhaps a foot and a half of shale containing large rounded masses, at times 15 inches in diameter which on closer inspection are seen to be chiefly a large nodulated species of some stromatoporoid sponge, and some large species of *Tetradium*. On the south side of the hill there are no exposures corresponding to the limestone beds on the north side, and there is no mottled clay layer, but over the stromatoporoid bed occur about seven feet of brown shales which must correspond therefore not only to the two feet of shales overlying this bed on the north side of the hill, but also to the four feet of mottled clay on the same side, and possibly, at the top, also to the limestone beds.

On the north side of the hill six feet of brownish fine fissile shales occur under the stromatoporoid bed, and lower down, three feet of blue clay. On the south side there are no exposures corresponding to the shales, but beneath, instead of three feet of blue clay as on the north, there are about six feet of this clay.

The layer containing the massive species of *Stromatopora* and *Tetradium* is also seen east of the road where exposed by small streamlets, on the eastern side of the hill. The boulderlike masses, especially those of medium size, are packed closely together. Similar layers occur in Kentucky at a similar horizon, that is near the top of the Lower Silurian, or the upper bed of the Hudson River Group, as it is called in that state.

In Kentucky however the layer is chiefly characterized by the presence of *Columnopora* and *Tetradium* instead of *Stromatopora* and *Tetradium*. As far as can be determined from the published reports,

this coral layer is but very poorly represented in Mason county, not at all in Fleming, fairly well in Bath county, but seventy-five feet below the top of the Lower Silurian; it occurs in Madison, also in Garrard, where in places the top of the Lower Silurian is marked by an irregular mass of limestone filled with *Columnaria* and *Tetradium* as usual; the layer is quite well developed in Lincoln, better in Marion and Washington; also in Nelson and Spencer, and these corals also occur in Shelby and Henry counties, and in Oldham.

It will be noticed that this bed is not well represented in the northeastern counties containing the Lower Silurian. It does not seem to have been noticed north of the Ohio, in Adams, Highland and Clinton counties. If it be considered desirable to bring the Morris Hill locality into relation with the great coral reefs of Kentucky which there mark the close of the Lower Silurian, this can be affected more readily by imagining the coral reef to have once extended across some of the more central counties, now exposing only Lower Silurian beds of a lower horizon. From these counties the coral reefs must then be supposed to have been removed by erosion in later times. I rather doubt, however, the former existence in Ohio of a continuous layer containing an abundance of stromatoporoid fossils, *Tetradium* and *Columnaria*. These fossils are probably distributed here chiefly in patches at somewhat varying horizons. One or two specimens of *Tetradium* were found just beneath the Clinton south of Eaton, Ohio. A stromatoporoid growth was fairly frequent about $3\frac{1}{2}$ feet beneath the Clinton, at Fair Haven. About 40 inches beneath the Clinton, at the Enterprise locality, very large growths of *Tetradium*, similar to those at Morris Hill, were found. At John Kneisly's farm on the Smithville road, 2 miles southeast of Dayton, *Stromatopora* and *Tetradium* occur 6 feet below the base of the Clinton in a clay bed.

14. *Marian Clark Farm. Lytle.*—Southwest of Lytle, perhaps half a mile across the country, is the farm of Dr. William Stokes. At the spring house behind his residence a rock crops out, which, according to Dr. Stokes, was identified by Prof. Orton as the Dayton limestone. It is a rotten rock, of uncertain character and presents, for Dayton limestone, the anomalous feature of rather frequent fossils shown in the form of exterior casts, the shells themselves having disappeared. Following the lane southwards about a quarter of a mile, the farm house of Marian Clark is reached. Directly east

of the same is a valley, on both sides of which the Clinton crops out. Following this valley northwards to a low waterfall the Clinton is seen to be underlaid by 5 inches of clay; under this are 7 inches of bluish shale, evidently only a phase of the blue clay. Below this is a layer, 7 inches thick, which is much firmer, and which has the character of the Belfast bed as seen in some of the more southeastern exposures. It is a bluish rock when freshly broken and can be split along the stratification. While not hard, it is much firmer than the blue shaly layers just above. Under this layer are 15 inches of blue clay. Beneath this begins the Cincinnati limestone with a layer containing coarse branching bryozoans. Less than three feet of material represent therefore the Belfast bed and the upper blue clay of the Cincinnati Group of other sections. The firm layer, to which reference was made, alone shows the characteristics of the Belfast bed. Following the little streamlet northward, the Clinton is seen to be a coarsely crinoidal rock, with scarcely a sign of a fossil except stromatoporoids. In the fields, where tiling has in part replaced the open course of the streamlet, a few fragments of Clinton rock of the higher horizons showed a finer grain and contained *Rhinopora verrucosa*, *Rhynchonella scobina*, *Strophomena patenta?*, and *Illænus daytonensis?*

15. *Thorp Farm*.—About two miles northwest of Waynesville, and two miles directly east of Lytle (Raysville), on the pike connecting these two towns, is the farm formerly belonging to Stephen Burnett, now the property of the widow Thorp, of Waynesville. Crossing from the house to the north side of the pike, and then past the barn diagonally westward through the orchard, a sort of gully is reached. Near its lowest part the Cincinnati rock is exposed. Overlying this are about three feet and a half of a blue clay, breaking into shaly fragments, or softening under the influence of the weather to a homogeneous clay. At the top two or three inches are hardened and brown. A side gully, running eastward, up the orchard already mentioned, shows instead of this blue clay a brownish shale, of which the pieces are very thin. This material corresponds in position to the Belfast bed and underlying blue clay of more eastern sections. It is evident that no part can here be discriminated as the Belfast bed and as distinct from the blue clay usually found at the top of the Cincinnati. Over this horizon is found the Clinton limestone, consisting here of coarse rock, made up of innumerable crinoid fragments,

with an occasional stromatoporoid fossil or cup coral, but practically destitute of other fossils. According to Prof. Orton a valuable ledge of Dayton limestone is found a few rods beyond in the fields. This Dayton limestone is well exposed about half a mile west of the Thorp farm, behind the house of Elizabeth Burnett, at the edge of the woods. Here the weathered sides of the Dayton limestone courses often show innumerable crinoid stems and beads, but of very small size, showing the crinoidal character of this limestone, a fact also noted at the Bigger quarry, on the Bellbrook pike, one-half mile S. of the U. P. church, south of Beavertown. The same feature is also noted at the John Kneisly farm mentioned on page 175. Fresh fractures do not even show a trace of these crinoidal remains. The Clinton immediately underlies the Dayton limestone. The upper courses are not exposed; only fragments thrown up by a drain were seen. These showed the presence of abundant *Rhinopora verrucosa*, a few specimens of *Leptæna rhomboidalis*, and a specimen of some species of *Phænopora*.

16. *Centreville*.—The quarry is about half a mile northeast of the village, and a half mile northwest of the railroad station. The Clinton here is well exposed, both the upper and lower contact being shown. Under the Clinton occur about 30 inches of a firm, fairly hard, greenish blue rock, evidently argillaceous. Layers are not so well marked in it as usually so far to the west is the case in the Belfast bed. The top of the Clinton limestone is wave-marked, the wave ridges being north 55° to 65° west in direction. Over this wave-marked layer occur 4 to 10 inches of the blue clayey or shaly Clinton, so often found near the summit of the Clinton in Montgomery county.

17. *Huston's Quarry*—three miles east of the Bigger quarry, the latter being 5.5 miles southeast of Dayton on the Bellbrook pike, one-half mile south of the U. P. Church. Huston's quarry lies in Green county directly north of Bellbrook. Here the Dayton limestone is well exposed. Much of it is of inferior quality. The uppermost layer shows many small crinoid stems and some bryozoans, and *Heliolites*. The Clinton beneath is reddish crinoidal; its total thickness is not exposed but can not exceed 4 feet in any event, since the base of the Dayton limestone is only about 10 feet above the base of the Belfast bed, and the brown shales of the Belfast bed are known to have a thickness of six and a half feet. The Belfast bed shales, in some of their courses, are hardly clayey, but rather firm, and

finely sandy. Beneath the Belfast bed are soft blue clayey strata, containing more firm, nodular masses, with bryozoan remains showing on their surface. About 15 inches below the base of the Belfast bed, a limestone course contains *Orthis occidentalis*, a lower Silurian species.

18. *Fauver's Quarry*—about two miles north of Dayton, west of the pike continuing Main street. The Clinton is well exposed at the quarry, both the upper and the lower contact being shown. Beneath the Clinton are 22 inches of shaley blue clay underlaid by 20 inches of hardened blue clay, the whole representing the Belfast bed.

19. *Keplinger Farm (Mark Allen's Quarry)*—a little more than a mile and a quarter south of Charleston falls, and on the National road, about half a mile directly east of Tadmor, on the Dayton and Michigan Railroad. The dwelling is now occupied by Mr. Keplinger.

Here the Clinton was well exposed, but was not measured. Beneath it were 24 inches of a fairly solid, massive, greenish blue rock, the Belfast bed; 112 inches of a fairly firm, bluish or greenish shale, clayey where more weathered, and 30 inches of a blue clayey shale. The base of the Clinton is about 80 feet above the level of Tadmor station. At least 24 feet of Clinton rock are exposed here, but the base of the Dayton limestone is not seen along the roadside and the total thickness of the Clinton is probably greater.

Going from this point a mile eastward, to the Troy pike, and thence southward, Shoup's quarry is reached about 7 miles from Dayton. Here the Springfield rock is worked; its base is about 28 feet above the base of the Dayton limestone, as seen about a quarter of a mile due west. Reckoning at least 4 feet as the thickness of the Dayton limestone, the following section is approximately true for this part of the country:

Clinton limestone from 24 to 27 feet.

Dayton limestone 4 to 5 feet.

Niagara shales (so-called) 23 to 24 feet.

Springfield limestone, 12 feet exposed.

The Clinton is well exposed beyond the Dayton limestone quarries, along the road, a quarter of a mile due west of Shoup's quarry. Here *Phenopora expansa* and *Ph. magna* were found. The base of the Clinton was not well seen. The Clinton is also seen at two

points along the Troy pike, south of Shoup's quarry, the most southern exposure being about 6 miles from Dayton. This is the most southern exposure along the road.

20. *West Charlestown Falls*—about half a mile southwest of the hamlet of that name on the Dayton and Troy pike, about a mile and a half south of Col. Woodward's farm. The Dayton limestone is here well exposed in the stream bed above the falls. The limestone is yellowish, much softer than the typical rock, apparently more argillaceous, and usually in layers not exceeding 3 or 4 inches in thickness. It looks much like the Ludlow Falls quarry rock, but is inferior in quality. The total exposure of the Clinton at this point does not exceed 27 feet.

At its base are 42 inches of a rather firm greenish blue argillaceous rock, in thick massive courses, though readily splitting under the hammer. This represents the Belfast bed. Beneath are 34 inches of similar bluish green rock, but more shaly, breaking up into thinner courses. Next are 9 inches of a firm, hard, fine-grained, blue limestone. Then 24 inches of soft blue clayey shale, 8 inches of hardened greenish argillaceous rock, 12 inches of softer clayey rock, 18 inches of a hardened greenish rock, and 16 inches of a hardened shaly clay rock, green, mottled with reddish purple.

20a. *John Cushwa's Farm*.—Southwest of West Charlestown Falls, on an east and west road, a little over a mile northeast of Tadmor station on the D. & M. Railroad is a roadside exposure, in front of the house occupied by John Cushwa. The Clinton is exposed at the top of the hill, its base being about 82 feet above the level of Tadmor station. The rock is pink or reddish, and contains numerous crinoid stems. The following fossils were found here: *Illænus ambiguus*, *Orthoceras* (*Spyroceras*) *spyroceroides*. There were two specimens of this species of *Orthoceras*. One of them was 38 mm. broad; about 9 transverse striations were found in a length of 6.5 mm. and 11 longitudinal striations in a length of 6 mm. In a second larger specimen, 6 transverse striations were found in a length of 6.3 mm. The longitudinal striations were also present. *Platyceras* (*Platystoma*) *niagarensis*, the small Clinton form, *Orthis fausta*, *Orthis elegantula*, *Rhynchonella scobina*, the small form, *Ptilodictya lanceolata* var. *americana*, with the lateral margins not waved, owing perhaps to the moderate size of the

frond, *Rhinopora verrucosa*, *Hemitrypa ulrichi*, typical, *Phylloporina angulata*, *Heliolites subtubulatus*, *Ptychophyllum ipomæa*.

21. *Col. Woodward's farm*—now occupied by another family. Going from Tippecanoe two miles east on the New Carlisle road and then south about a quarter of a mile, the house on the west side of the road, is reached. South of the house is a shallow ditch exposing the Clinton with *Heliolites subtubulatus*, *Halysites catenulatus*, *Fenestella* (*Hemitrypa* ?), *Rhinopora verrucosa*, *Pachydictya instabilis*, *Orthis elegantula*, *Rhynchonella scobina*, and *Platyceras* (*Platystoma*) *niagarensis*.

The total section of the Clinton at this point was almost 23 feet. This being about the highest exposure on the hill, the original Clinton at this point may have been somewhat thicker. See the Charleston Falls section. At the base of the Clinton there is a white, fine-grained layer, more sandy in texture, and about 7 inches thick, here included with the Clinton.

Beneath is a hard greenish layer, 3 inches thick, then 8 inches of a soft, clayey, greenish shale. Then about 8 or 9 feet where there is no exposure. Next, 23 inches of a very fine grained light brown limestone including some thin blue more argillaceous layers, breaking up into shaly fragments. Below this were about 6 feet without exposure, underlaid by a series of thin bluish or brownish shales.

22. *Troy High Banks*—three miles south of Troy, and two miles north of Tippecanoe, along the western side of the Dayton and Michigan railroad track. At the top of the banks the Clinton is exposed. Its color exteriorly is brownish, owing to long continued weathering but interiorly it is seen to be a whitish, coarsely grained limestone, practically unfossiliferous. Beneath it are six and two-thirds feet of a light brown rock, more massive than the shales beneath, in layers two and a half and three inches thick, frequently crossed by cracks, and unfossiliferous. It is more unlike the Belfast bed as seen farther eastward and southeastward than the exposures at Goe's Station and Donnelsville, but it has the same thickness and occupies the same position. Beneath the more massive rock are twelve feet of blue thin shales, with annelid teeth towards the top. Below are one and a third feet of a very fine grained limestone, underlaid by the same thickness of blue shale, beneath which is a foot in thickness of limestone layers, of Cincinnati age, as shown by the presence of *Orthis occidentalis* and other fossils. Beneath this are

12 feet of material, blue shale at the top, but apparently more clayey below. How far beneath this level the regular limestone layers of the Cincinnati group are found is not known at present with certainty. The 26 feet below the Belfast bed are all here included in the Cincinnati group.

23. *Piqua*.—Going from Troy northward on the electric cars to Piqua, Statler's quarry is found $1\frac{1}{2}$ miles south of Piqua. Here the Dayton limestone is quarried. Half a mile south of Piqua the Clinton is exposed along the side of the track. At this point were found *Illænus daytonensis*, a glabella, *Phænopora magna*, *Heliolites subtubulatus*, *Halysites catenulatus*, and *Ptychophyllum ipomæa*. On the eastern side of the bridge at Piqua was exposed the Clinton with *Strophomena patenta*, and typical specimens of *Pachydictya bifurcata*. The thickness of the Clinton was at least 20 feet. Its total thickness was not certainly known. Going down the eastern side of the Miami river, to a point opposite Statler's quarry, at Huffman and Horn's quarry, the Dayton limestone is quarried. It contains not infrequently fossil remains at the surfaces along the bedding planes. The Clinton is exposed below, and shows very few fossils near the top.

24. *Ludlow Falls*—one mile west of the Stillwater, and two and a half miles north of West Milton. Here the Clinton is overlaid by stone corresponding to the Dayton limestone. The courses are however only 4 to 6 inches thick, and there is a greater thickness to the total section of this variety of limestone than farther south or south-east. There are at least 6 feet of rock of fair quality; it graduates upwards into the stone which near Dayton is included in the Niagara shale. Elsewhere the transition from the Dayton limestone into the Niagara shale series, even when the name shale is a misnomer, is more sudden. There is no marl or clay intervening between the Dayton limestone and the Clinton. The Clinton is at least 16 feet thick at the falls, and to this 4 to 6 feet must be added in order to bring the section up to the level of the junction of the Clinton and the Dayton limestone as shown in the cut near the railroad depot. This would give the Clinton a total thickness of 20 to 22 feet. The Clinton here is not very fossiliferous, though quite a number of forms were found in the upper Clinton, when the cut along the railroad, mentioned above, was made. Underlying the Clinton are two and a third feet of blue argillaceous but quite firm stone, in layers usually

2 to 3 inches thick. This stone corresponds to the upper harder rock at the High Banks between Tippecanoe and Troy, but is apparently less firm. Below it are 5 feet or more of a blue shale, more clayey and more soft than that above, and in thinner courses. These softer rocks are readily loosened by the combined effects of moisture, weathering and frost, and by receding have caused the falls. The upper firmer layers decrease in thickness towards the south side of the falls. If they represent the Belfast bed of more eastern sections as is believed to be the case, they certainly have changed considerably from the typical form of the rock.

25. *West Milton*—on the Stillwater river, 15 miles northwest of Dayton. The Clinton is here well exposed along the road leading down from the main street eastward to the river bridge. On the west side of the river, immediately facing the bridge, is a steep cut made by a rapidly descending streamlet. At its top the Clinton is again well exposed. Underneath it are 58 inches of a blue shaly clay. Then, 8 inches of a hardened blue clay in a single layer, similar to some of the rocks called the Belfast bed in more eastern regions, for example at Goe's station. Beneath this are 62 inches of blue shaly clay, in the lower 2 feet of which were found specimens of *Orthis biforata*, the Lower Silurian forms with fairly broad plications. Then in descending order: 14 inches of blue clayey shale, 12 inches of a hardened shale or clayey limestone, 16 inches of a hardened rock, which breaks up in shaly pieces, 9 inches of a hard blue rock, a 3 inch course of similar material, 13 inches of blue shale, and 9 inches of poor clayey limestone with *Tetradium* and *Orthis occidentalis*. Next, 9 inches of soft blue clayey shale, cut back by the streamlet, a 9 inch slope of hardened shale, 6 inches of soft limestone breaking up into shaly fragments, 12 inches of blue shale, rather soft, with *Orthis occidentalis*, *Orthis biforata*, *Orthoceras*, and Lower Silurian bryozoa. Then come harder courses, first as a 16 inch slope, then in 4, 6, and 8 inch layers, then 8 inches of a shale, between blue and brown in color, forming with the 8 inch hard layer just above a vertical face. This hard layer had on its upper side the appearance of having been gouged out by a tool about a tenth of an inch wide, the sides of the cavities being straight, the length an inch or less, the depth hardly more than a quarter of an inch, and the bottom a regular concave curve. Similar markings were seen in the Lower Silurian rocks of a bridge pier in Clinton county, northeast of Spring Hill several miles. Below the

shale bed mentioned above were 60 inches of shale, blue and brown in color, interrupted towards the top at two levels by a course of harder material about one and a half inches thick. At this depth the regular Cincinnati limestone beds had not yet been reached. But it is evident from data furnished above that only a very small thickness of this section could under any circumstances be referred to the Belfast bed.

A fine section exposed at the falls in the Stillwater, a short distance north of the village was not visited.

26. *New Paris.*—Going from New Paris to the western margin of the town, the Springfield rock is exposed on the southern side of the road. A quarry shows about 25 feet of this stone, and the material here obtained is used for the manufacture of lime. On the northern side of the road, about a sixteenth of a mile distant, along a lane, the Dayton limestone is exposed. It possesses all the characteristics of the same horizon at Laurel, Indiana, where it forms the typical exposure for the so-called *Laurel bed*. Its upper courses are frequently interbedded with chert layers. Crinoidal fragments are not uncommon here in certain layers of small vertical and lateral extent. The lower part of this formation is made up of thicker courses, without the interbedded chert beds, or at least with comparatively little chert material. Still farther north, on the north side of the creek, near a fork in the road to Richmond, the Clinton is exposed.

27. *Euphemia.*—Euphemia is about a mile north of Lewisburg, on the road to West Sonora. About half a mile northwest of Euphemia, near the railroad, are the quarries of I. J. Weaver. Only one or two feet of Springfield rock are exposed and are burnt into lime. Below this are eleven feet of a magnesian limestone, hard and blue when fresh, showing along many courses an abundance of small crinoid remains. This rock corresponds to the upper half of the Dayton stone at New Paris with its interbedded chert remains. At Weaver's quarry there is no chert, but the narrow bedding of the rock is similar. Beneath is found a foot and a half of harder blue clay, underlaid by two and a half feet of a softer blue shaly clay. Below this are found eight and a half feet of good quarry stone, corresponding to the lower half of the Dayton stone as exposed at New Paris. Underneath the Dayton stone occurs the Clinton,

exposed during the blasting of a drainage trench. In the Clinton were found *Cyclonema bilix*, *Orthis fissiplicata*, *Orthis elegantula*, *Pachydictya* (*Rhinodictya* ?) *rudis*, *Rhinopora verrucosa*, *Callopora magnipora*, *Heliolites subtubulatus*, *Favosites favosus*, *Striatopora flexuosa*, *Halysites catenulatus*, *Syringopora* (*Drymopora*) *fascicularis*, *Ptychophyllum ipomœa*, a fine specimen 4 inches broad and $1\frac{3}{4}$ inches high, *Diphyphyllum cæspitosum*, and *Chonophyllum niagarens*

28. *Lewisburgh*—twenty miles a little north of west of Dayton, on Twin Creek. About half a mile south of Lewisburgh, on the east side of the pike, on the land of Mr. James Stetler, is a ditch leading from a culvert on the pike directly eastward to a rocky descent which gives rise to a waterfall in wet weather. In the ditch the Dayton limestone is exposed. Its color is yellowish and it does not look as though it would wear well. Below it lies the Clinton, almost 13 feet thick. It is a limestone, coarsely granular, more or less crinoidal, but otherwise with but few fossils. The upper part is stained more or less brownish by iron compounds, and the lower part is nearly pure white in color. Luckily a good pygidium of *Illenus daytonensis* was found about 8 inches above the base of the Clinton, thus corroborating its recognition by lithological methods. This was very necessary since the Clinton at its base is immediately underlaid by a 3 inch course of hard bluish limestone with *Orthis occidentalis* and many branching Lower Silurian bryozoa. This makes it necessary to draw the dividing line between the Upper and Lower Silurian formations between two immediately adjacent limestone beds. The result is that the Belfast bed is seen to be totally absent here. One to three inches at the base of the Clinton limestone are more or less streaked with thin greenish tinged shaly layers, but this need not be the Belfast bed. Below the 3 inch layer of Lower Silurian limestone mentioned above, are about 3 feet, of which the upper part can be seen to be blue clayey shale, and the lower part, though not exposed, is probably the same. Beneath are 4 inches of a hard fine-grained limestone. Then comes an interval in which no rock was found, there being no exposure. Without instruments it was impossible to measure this interval accurately, but 11 or 12 feet was assumed as fairly accurate. Below this came 19 inches of a hard, blue, very fine-grained limestone, whose upper surface was marked with glacial scratches running approximately north and south. Below this were 25 inches of blue

shale, in part clayey, and in part more firm, the latter with Lower Silurian bryozoa.

Farther north, towards Lewisburg, on the west side of the pike, is the quarry belonging to Mr. William Turner. The lower half of the quarry belongs to the upper half of the Dayton limestone as exposed at the Weaver quarry northwest of Euphemia. It is a firm blue rock where not weathered, and contains no intercalated chert beds. Above this lies the more magnesian Springfield rock containing *Pentamerus oblongus*. It is quarried for lime.

29. *Carl Quarry*—about $3\frac{1}{2}$ miles, a little west of south, from Lewisburg is found the quarry of James Carl, some distance up a small stream. The Clinton here is at least as thick as south of Lewisburg, 13 feet. At the quarry the Dayton limestone is exposed. The blue clayey shale near the middle of the Dayton section, so well exposed at the Weaver quarry northwest of Euphemia, is also seen here. Above this clayey shale is found the upper half of the Dayton limestone section, containing in some layers abundant crinoidal remains. Specimens of *Pisocrinus gemmiformis* and of a *Stephanocrinus*, apparently *St. osgoodensis*, were found in this upper part of the Dayton stone.

30. *Crisman's Quarry*—half way between Carl's quarry and Eaton, about three miles northeast of Eaton, at a place recently called Rocky Point. Here the Dayton stone is exposed.

31. *Eaton*.—West of town, in the creek bed, the dolomitic rocks, elsewhere called Springfield and Cedarville beds, where distinguishable, are well exposed. The characteristic fossils of this division of the Upper Silurian are found. *Pentamerus oblongus*, and the form of *Calymene niagarensis*, which belongs to this bed, are common. Below this, towards the bridge across the creek, are found the upper beds of the Dayton stone, firm, in regular layers, serviceable as flagging stones, and without the interbedded chert layers seen at New Paris and north of Fair Haven.

32. *Eaton, Clinton Quarry*.—Going from Eaton southward, about two miles on Seven-mile creek, a fine exposure is reached in the neighborhood of the place where the P. C. & St. L. Railroad crosses the creek. The Dayton limestone is light blue in color, looks dolomitic, and seems to grade into the Niagara rock above, as it does also at Ludlow Falls, where, however, it partakes more of the

character of the Dayton limestone. Beneath this lies the Clinton, having here a thickness of about twelve and a half feet. About the same thickness was measured at Lewisburg. At the top of the Clinton, the rounded species, *Favosites favosideus*, was rather common. Beneath, in bluish, purplish or reddish Clinton, were found: *Orthis elegantula*, *Rhinopora verrucosa*, *Phylloporina angulata*, *Favosites favosus*, and *Halysites catenulatus*. About 7 feet below the top of the Clinton occurred about 15 inches of a very white stone, containing fragments of *Hemitrypa ulrichi* rather abundantly. *Pachydictya turgida* and *Strophomena patenta* also occurred here. The total thickness of the Clinton here is about 13 feet.

Going down the creek from this point a moderate distance, the Clinton is found to be underlaid by greenish blue shaly courses, of which at least three feet are exposed. A small specimen of *Tetradium* was found within a foot of the base of the Clinton, thus testifying to the Lower Silurian character of these shales. Lithologically, however, they occupy the place of the shaly courses elsewhere called the Belfast bed in this western region of exposures. Above the shale exposures just mentioned the Clinton forms a steep wall. Huge blocks of Clinton have fallen down at one point, and a coarse wave marking was noticed on the face of one, indicating the presence at this locality of a wave marked layer of not very great distinctness at about the middle of the Clinton.

33. *Enterprise locality*.—From Ingomar on the Cincinnati, Jackson and Mackinaw Railroad, south three fourths of a mile to the north end of Enterprise; then one mile west, and one third of a mile south. At this point on the southern slope of the hill, near its top, the road crosses an exposure of Clinton. The part actually in sight comprises only a few inches the lower 10 of which are finer grained, much decayed, and hence brownish. Some of the upper layers were evidently coarsely crinoidal, as far as can be judged by loose boulders. Beneath the Clinton were 12 inches of greenish clay, next, limestone fragments with *Orthis biforata*, *O. occidentalis*, and *Tetradium*. Perhaps 40 inches beneath the Clinton, therefore next in order, is found a layer containing very large growths of *Tetradium*, there being several masses 4 feet in diameter and 15 inches high. On top of these corals, stranded, and imbedded in the mud covering their upper surfaces are a number of specimens of *Paleaster* and *Agelacrinites*, and several

specimens of some species of *Encrinurus*. Beneath the *Tetradium* layer was a 3 inch course of a medium grained limestone, through which some animal from the layer above, had bored vertical tubes, later filled up by a finer limestone material.

The massive *Tetradium* so close beneath the Clinton rock, recall the similar layer at Morris's Hill, half mile north-east of Dodd's station, which at that place, however, occurs about 12 feet below the base of the Clinton.

34. *Fair Haven*.—Crossing the bridge north of Fair Haven, ascending the creek along its western side, as far as the first culvert, and then going up a small branch which enters from the west, until it has been traced to an open field beyond the woods, an exposure of the Clinton is found. The Clinton is here at least $7\frac{1}{2}$ feet thick. Beneath the Clinton is found a layer of a finely stratified white solid rock, more sandy than any other rock at this locality; its thickness is almost 1 foot. It contained a specimen of *Strophomena alternata*.

Beneath this hard rock is found a green shaly clay about $1\frac{1}{2}$ feet thick. Farther up the creek the upper part of this clay assumes the characters of a hard rock and contains *Orthis occidentalis*. Under the clay layer occurs a limestone, 1 foot thick. This limestone, especially in the bed of the stream, very much resembles lithologically the Clinton, and with this it was formerly confused by the writer. But it contains that Lower Silurian form of *Orthis biforata* which has wide plications; also *Orthis occidentalis*, *Strophomena alternata*, *Strophomena alternata* var. *fracta*, and *Strophomena filitexta*. Under this limestone is found a layer of blue shaly clay about 8 inches thick. This contains great growths of Stromatoporoid fossils in places. Underneath is a layer of limestone 8 inches thick, and this in turn is underlaid by 2 feet of a blue shaly clay. From a study of these later observations it will be seen that no space is left for the existence of the Medina at this place. What was formerly considered the Medina now turns out to be without doubt the Lower Silurian.

B. *A Study of a portion of the Upper Silurian Rocks of South-eastern Indiana, and their correlation with equivalent strata in Ohio.*

The Upper Silurian strata of Ohio have been more or less definitely identified with various New York horizons. Only two formations are richly fossiliferous. The lower one of these has been identified with the Clinton, and the upper one, with the Niagara of New York. The upper fossiliferous formation is a dolomitic stone, and at many points in Ohio is burnt into a fine quality of lime. It shows abundant fossils at Cedarville and at many other localities in Ohio. The lower portion of this dolomitic stone is often less fossiliferous than the upper portion, has a bluer color, comes out in more even courses, and contains a greater abundance of *Pentamerus oblongus*. Hence the lower, less fossiliferous dolomitic stone is distinguished as the *Springfield rock*, while the upper more fossiliferous portion is called the *Cedarville rock*. Both the Springfield and the Cedarville rocks contains Niagara fossils of the type described from Illinois, near Chicago, and from Wisconsin, near Racine. They have also many species in common with formations in New York and adjacent Canada, which are associated with the Niagara.

In Adams county and in portions of Highland county the dolomitic Niagara rock is underlaid by a more argillaceous fissile shale. This was identified with the Niagara shale of New York. Even in the more northern counties of Ohio, where this horizon is not occupied by a shale, but by an argillaceous stone forming courses of moderate firmness often 4 to 8 inches thick, the rock is still called the Niagara shale. Although sometimes quite firm, this stone is usually not suitable for building purposes since it deteriorates under the influences of weathering. Since this formation is practically non-fossiliferous, the chief reason for calling it the Niagara shale is its position below the dolomitic rock which is undoubtedly Niagara, although more of the type of the upper Niagara of New York. The fact that this lower horizon is shaly in the south-eastern counties nearer the Ohio river assisted in this determination.

Beneath the "Niagara shale," of Ohio, whether shaly or not, occurs a hard white limestone 3 to 5 feet thick, and then, lower down, a very pure limestone, becoming more siliceous eastward, locally, in the region of the Clinton conglomerates. This lower formation varies from 10 feet in the west to 24 feet near Dayton, and 35 feet and more in its most eastern exposures. It is the lower one of the formations

mentioned above as containing abundant fossils. Since this lower limestone occurs beneath the Ohio rock layer identified with the Niagara shale of New York, it was natural to call it the Clinton formation. The identification was based, however, more upon stratigraphical than paleontological grounds. Comparing the fossils described as coming from the Clinton of New York with those undoubtedly found in the so-called Clinton of Ohio, a number of identical species was found. This is not at all surprising when it is remembered that the Clinton formation in both states represents an earlier stage of development than the Niagara and that in both states these faunæ are found just beneath the Niagara. The identity between the Clinton faunæ of the two states on closer examination is not found to be so close as at first supposed. Whether this is due to geographical causes, the Clinton of New York being more litoral, or whether it is due to moderate differences of horizon, can not be told until the Clinton of New York is much more closely studied. Although I have been accustomed to call the Ohio formation the Clinton, yet I should be willing to recognize the fact that the identity is not very marked, by giving it a name of its own, for instance, the *Montgomery formation*, on account of its typical development in Montgomery county, in Ohio.

Below the Ohio Clinton was found along the eastern and northern lines of outcrop, a layer of more argillaceous and sandy material, forming in some parts of the state a quite firm stone. This is especially true along the more eastern line of outcrops, where the greater abundance of lime in this stone gives it a firm texture. This formation is very rarely fossiliferous, if the presence of annelid teeth be omitted. Since this formation, rarely exceeding 5 feet, occurs below the limestone identified with the Clinton and has a sandy character, it was identified at various times as the Medina. The presence of *Halysites catenulatus* discovered at an eastern locality in Ohio recently would seem to confirm this. The occurrence of this one fossil is however not determinative in face of the fact that when the formation is traced westward it shows undoubted Lower Silurian fossils in the corresponding formations there. It simply illustrates the fact observed before, that, in many cases Upper Silurian fossils in Ohio seem to have been introduced from the east. This is shown by the observation that certain fossils occur as low as the Clinton in more eastern localities, in New York and Pennsylvania, but do not make their appearance in the Clinton of Ohio, while they are found in the

undoubted Niagara of this state. The occurrence of *Halysites* in the eastern portion of the argillaceous sandy bed might belong to the same order of events. This bed, formerly identified as the Medina, has been designated in the preceeding pages as the Belfast bed, from its most typical region of development in Highland County in Ohio.

Between the Clinton or Montgomery bed and the "Niagara shales" is found everywhere in Ohio a firm white or bluish pure limestone, sometimes somewhat argillaceous, or magnesian, which evidently merges in some cases into the "Niagara shales" above, and which in all cases is readily distinguishable from the Clinton below. Its fossils are not of the Ohio Clinton type but evidently herald a new horizon. Many species are identical with the Niagara as identified in Indiana, at Waldron and at other localities. This is called the Dayton stone in Ohio.

Omitting therefore all reference to the Lower Helderberg limestone, the Hillsborough sandstone, and the Guelph, as a formation separate from the Cedarville bed, we have in Ohio the following series for the lower part of the Upper Silurian:

Dolomitic stone,	{ Cedarville bed, Springfield bed,	}	
More argillaceous stone,	{ Niagara shales,	}	Niagara.
White pure limestone,	{ Dayton stone,	}	
Pink or red pure limestone,	{ Clinton rock or Mont- gomery bed,	}	More Niagara than Clinton, perhaps.
More sandy and argilla- ceous stone.	{ Belfast bed,	}	Lower Silurian.

In the southeastern part of Indiana the corresponding rocks are as follows:

More argillaceous material,	{ The Waldron shales,	}	
White or bluish pure lime- stones, with intercalations of chert in the upper half,	{ The Laurel bed, (Osgood Phase.)	}	Niagara.
White, red, or brown pure limestone, or in one lim- ited region a hard blue sandy rock,	{ The Clinton rock or Montgomery bed,	}	More of Niagara than Clinton type, perhaps.
Very argillaceous rock, a clay, or, sometimes, mod- erately hard, clayey shale,	{ Western extension of the Belfast bed,	}	Lower Silurian.

When it is attempted to correlate the Indiana with the Ohio section, it is found that the Belfast bed in Indiana shows all the characteristics of the Belfast bed in its exposures west of the eastern and more typical line of outcrops in Ohio.

The Clinton of Indiana, though often much thinner than the Clinton of Ohio can easily be recognized and distinguished as a separate formation from the rocks above and below.

The typical Laurel bed is recognized as a mass of well bedded white or bluish-white limestone, easily quarried as flagging stones, which at New Point and to a less degree, at Osgood, shows few intercalated chert beds, but which near Laurel and Longwood contains a considerable number of these chert beds intercalated between the upper half of the limestone layers. North of Osgood the basal portion of this Laurel limestone formation is richly fossiliferous and this portion might hence be appropriately called the Osgood phase of the Laurel formation. It will not do however to imagine that it could be distinguished from the rest of the Laurel formation as a separate bed, since the two species, *Pisocrinus gemmiformis*, and *Stephanocrinus osgoodensis*, which characterize it, are also found in the upper part of the formation at the quarry south-west of town. A great part of the remaining species occur in the Waldron shales, which belongs immediately above the Laurel formation. The Laurel formation can be readily identified 2 miles north of Fair Haven and at the west end of New Paris, where the corresponding rocks include even chert layers interbedded so characteristically in the upper part of the Laurel formation at Laurel. The Laurel formation can also be readily identified north-west of Euphemia, and at James Carl's quarry, 3½ miles south-west of Lewisburgh, although the intercalations of chert in the upper beds at these localities are absent. At the latter locality the upper part of the formation even contains *Pisocrinus gemmiformis* and *Stephanocrinus osgoodensis*, as in this formation at Osgood. A close examination of the rock north-west of Euphemia suggests that it is not impossible that the upper half of the formation, above the clayey and shaly layers, represents the so-called "Niagara shale" of more eastern region. Going to the exposures at Ludlow Falls, this suggestion is strengthened since here the Dayton stone is seen to merge gradually upward into a more magnesian and at least softer and more drab colored or brownish rock, such as is called the "Niagara shale" in Montgomery county and elsewhere, when more readily distinguished

from the underlying Dayton stone, notwithstanding the fact that it is not a shale but a fairly firm stone occurring in layers from 4 to 8 inches thick. Of course in the more south-east counties, where these rocks are exposed, they turn into actual shales, but that is not the question here. I am therefore convinced that the Laurel formation in its complete form as seen in Indiana and western Ohio includes both the Dayton stone and the overlying Niagara shale of more eastern and south-eastern Ohio.

The Waldron shale overlies the Laurel formation. In my opinion it is paleontologically and stratigraphically slightly earlier than the great mass of rocks usually classed as the dolomitic form of the Niagara. I am not inclined as yet to distinguish the Springfield rock from the Cedarville rock as a separate paleontological horizon. I should call the two rocks a single horizon. The Waldron bed in my point of view represents a bed intermediate between the Laurel formation and this dolomitic form of the Niagara, or rather it really is a sort of transition rock in Indiana. This being the case it is not surprising to find in it species occurring in the Laurel formation at Osgood, and at the same time species, which certainly have close relationship to those found in the dolomitic Niagara in the northern part of the State and in Ohio. Lithologically I should call the Waldron shale a shaly phase of the upper Laurel bed; stratigraphically and paleontologically, a transition bed towards the dolomitic Niagara. What is meant by calling the Waldron bed lithologically related to the Laurel bed is simply this: the upper part of the Laurel bed is not infrequently more shaly, so that locally it might merge into a series of shales. At the same time it is not a distinct transition lithologically from the purer limestone to a dolomitic limestone.

35. *Richmond*.—Going from Richmond about two and a half miles northeastward in the direction of Middleborough, to the bridge across the Middle Fork, the Clinton is found exposed in the form of great slabs, let down by the gradual decay of the Silurian rocks beneath to lower and irregular levels. The Lower Silurian limestone is found at its original level on the west side of the road south of the bridge. The Clinton contains *Orthis calligramma*, of a medium number of plications, *Orthis (Platystrophia) biforata*, *Strophomena patenta*, *Meristella umbonata*, *Rhinopora verrucosa*, *Heliolites subtubulatus*, *Heliolites megastoma?* and *Favosites favosus*.

36. *Elkhorn Falls*.—About 4 miles nearly south of Richmond are found the Elkhorn Falls. The Falls themselves are composed of the Clinton formation which at this point is $14\frac{1}{3}$ feet thick. Below the Clinton the firm greenish blue Belfast clay rock is found with a thickness of 15 inches. Underneath this is found a shaly blue clay, about 3 feet thick under which is seen the ordinary Cincinnati limestone with *Strophomena alternata*. Over the Clinton is found the Dayton limestone, which is softer near the base, firmer and more blue farther up. The total thickness of Dayton stone exposed here does not exceed 3 or 4 feet.

In the Clinton were found *Illænus daytonensis*, glabella and pygidium, *Illænus ambiguus*, pygidium, *Dalmanites werthneri*, pygidium, *Orthis calligramma*, *Orthis bifurcata*, few plications, *Orthis elegantula*, *Strophomena patenta*, abundant, and *Favosites niagarensis*.

The Clinton here is often a whitish, bluish, or reddish very pure limestone, like the upper half of the limestones at Soldier's Home Ohio.

37. *Longwood*.—6 miles west of Connersville on the Cincinnati, Hamilton & Indianapolis Railroad.

a. *Ball's quarry*.—This quarry is found along the creek west of the railroad station. It is the most northern of a group of quarries opened along the creek. The Clinton here is about $11\frac{1}{3}$ feet thick. It is a hard blue sandy siliceous rock, very different from the ordinary Clinton away from some of the eastern exposures in the region of the Clinton conglomerates. It contained *Leptæna rhomboidalis*, an obese form of *Atrypa marginalis*, *Phylloporina angulata*, *Pachydictya rudis*, *Rhinopora verrucosa*, *Heliolites subtubulatus*, *Striatopora flexuosa*, and *Halysites catenulatus*. Underneath the Clinton occurs a layer of hard limestone rock, 8 inches thick, with abundant specimens of both valves of *Orthis occidentalis*, and of various Cincinnati Group bryozoans. Underneath was a blue clayey shale. Chert beds occur in the Cincinnati about 20 feet below the base of the Clinton.

Above the Clinton occur 6 feet of rock too soft to be used for building purposes and hence not quarried. It is of a yellowish color. In the lower part of this rock occurs a layer containing numerous specimens of *Orthoceras*. Above this occur a little over 4 feet of a blue flagging stone, free of chert, and constituting the chief part quarried for use. This, with the 6 feet of softer rock already men-

tioned constitutes the lower part of the Dayton stone of Ohio, or the Laurel bed of Indiana. Above this are found the cherty layers of the Laurel bed, beginning below with 2 inches of chert, followed by 15 inches of good flagging stone, 3 inches of chert, 13 inches of rock, 1 inch of chert, 1 foot of rock, and 1 foot of chert, evidently once belonging to different layers, but now all heaped together in consequence of the weathering away of the limestone layers which once separated them.

b. Washam's quarry occurs about a mile south of Ball's quarry. The flinty beds of the Laurel bed (Dayton stone) are worked here. The rock seems to pass gradually downwards into the Clinton. At least no very satisfactory line of demarkation lithologically could be discovered. The Clinton here, where undoubtedly recognized, is a blue hard siliceous rock, like that at Ball's quarry. Only $4\frac{1}{2}$ feet of Clinton could be identified with certainty. It contained *Syringopora* (*Drymopora*) *fascicularis*, *Halysites catenulatus* and *Favosites niagarensis*.

Under the Clinton occurred a blue clay layer. Lower down the creek blue siliceous rocks, weathering to red, and similar to the siliceous Clinton above, are found. Being below a blue clay bed, they are considered Lower Silurian rocks, but no fossils indicating this horizon were found. The sections between this place and Laurel should be carefully studied. At Laurel the most northern exposures show the Clinton reduced to a thickness of 8 inches. There must be an interesting problem involved here to account for this sudden thinning out of the Clinton in going southwards about 10 miles. Moreover the Clinton in this distance has changed lithologically from a hard siliceous fine grained rock at Washam's quarry to a softer, pure limestone, more fossiliferous at the Laurel quarry. The siliceous form of the Clinton is also absent at the Middle Fork exposure north-east of Richmond, at the Elkhorn Falls, and at Fair Haven. The distribution of this siliceous phase of the Clinton is therefore worthy of study. It is evidently a local phase of the Clinton.

38. *Laurel.—a. Dry Branch or Geyer's quarry.* This quarry is found along the road about two miles north-west of Laurel. The Clinton here is only 8 inches thick. It is a softer, and less blue rock than the uppermost layer of the Cincinnati group beneath. It has a granular texture and contains a small form of *Orthis calligramma*, of the type found at Hanover, Indiana, also *Pachydictya bifurcata*, *Pachy-*

dictya obesa, *Rhinopora verrucosa*, *Heliolites subtubulatus*, *Favosites favosus*, *Cyathophyllum celator*, var. *daytonense*, and a large specimen of *Ptychophyllum ipomæa*. Under the Clinton was a layer of blue clay 21 inches thick. Below this was a layer of coarsely granular Cincinnati limestone, resembling the Clinton lithologically, 7 inches thick, and containing *Plectambonites sericea*, *Strophomena alternata*, also var. *fracta*, *Strophomena planumbona*, *Orthis occidentalis*, and *Orthis biforata*, Lower Silurian type.

Above the Clinton is a soft brown stone, similar to the lowest part of the Laurel bed at Ball's quarry near Longwood. There may be about 6 feet of this soft rock. Above this occur about 3 feet of a very hard, firm white rock, very much like the Dayton rock in Ohio. These two kinds of rocks above the Clinton constitute the lower half of the Laurel formation. Above these occurs a rapid alternation of chert and stone over 6 feet in thickness forming a characteristic exposure of the upper half of the Laurel formation.

b. Henry Dice's quarry.—One mile south of Geyer's quarry. The Clinton here was 24 inches thick. The exposure was otherwise similar to that at Geyer's quarry.

c. Seegar's quarry.—One mile south of Dice's quarry. The Clinton was here a reddish crinoidal limestone 33 inches thick. Beneath it occurred 2½ inches of blue clayey shale, 2½ inches of stone, 2½ inches of blue clayey shale, 2½ inches of stone containing *Plectambonites sericea*, *Strophomena filitexta*, and *Orthis occidentalis*. Beneath this were 2 feet of blue clayey shale. Farther down was a considerable abundance of clayey shale.

d. Chris Mead's Falls Quarry.—Half a mile south of Seegar's quarry. Here the Clinton was 90 inches thick. A large part had a crinoidal character, but a portion had the appearance of the brownish Clinton from Hanover, Indiana. Immediately below the Clinton was blue clayey shale, containing loose typical Cincinnati Group fossils within several inches of the Clinton. Above the Clinton was a brown, soft rock, in thin courses, forming the basal portion of the Laurel formation (Dayton stone.) The middle and upper portion of the Laurel bed with its intercalated cherty beds was well exposed in the quarry near by.

The Clinton at this point contained *Illæmus daytonensis*, glabella and pygidium, *Calymene vogdesi*, large pygidium, *Plectambonites trans-*

versalis, var. *elegantula*, *Strophomena hanoverensis*, *Leptæna rhomboidalis*, *Atrypa marginalis*, var. *multistriata*, common, *Orthis calligramma*, the same form as that found at Hanover, *Clathropora frondosa*, good specimens, *Rhinopora verrucosa*, *Hemitrypa ulrichi*, *Phylloporina angulata*, *Heliolites subtubulatus*, *Favosites venustus*, *Favosites favosus*, and *Halysites catenulatus*.

This is the most northern appearance of rock lithologically resembling the Clinton from Hanover Indiana.

c. Derbyshire Falls.—About half a mile south of Chris Mead's quarry. The Clinton is here at least 90 inches thick. Beneath the Clinton is plenty of bluish clayey shaly rock, wearing away more rapidly than the Clinton and forming a deep fall. A more picturesque fall lies about a quarter of a mile towards the northeast.

Inside of a few miles the Clinton has increased from 8 to 90 inches. Towards the north the Clinton not only thickens to 135 inches, but becomes siliceous and fine grained and sandy in texture. Fourteen miles towards the south, at New Point, it again becomes thinner, being reduced to 35 inches. Three miles farther south the Clinton is hardly over a foot thick, and at Osgood it is again 28 inches thick. At several places the thinning out of the Clinton is, to say the least, phenomenal. The extension of the Clinton, east and west, is so considerable in Franklin county, that it may be possible here to find a solution for the great variation in thickness of this formation in Indiana. It is not improbable that such a solution would include interesting suggestions as to the history of this marine basin during Middle Silurian times, possible land conditions, and questions of early folds in strata now forming part of the Cincinnati anticlinal.

39. *New Point.*—North of New Point about a mile, are numerous quarries opened up in the Laurel formation (Dayton stone) This rock is much eroded at the top, and the chert debris from higher beds have fallen down into the crevices and have been covered by gravel and soil. There are no chert layers intercalated with the flagging at this quarry. The rock is singularly free of chert in general although several layers include nodules of chert in moderate quantities. The Laurel bed, where not weathered, in the quarry, is firm and sound to its very base. In fact in some cases the upper 6 inches of the brown Clinton and the lower 6 inches of the white Laurel formation have come out of the quarry as a single firm block. East of the quarry,

however, along the creek, the weathered Laurel formation is more shaly and thin bedded below. The Clinton here has a thickness of 35 inches. It is in large part brownish in color, like the Clinton at Hanover. Immediately below is a bluish white limestone, as white as the Laurel formation rock, but containing *Strophomena alternata*. Below, this white rock changes to more blue, and its total thickness is 10 inches. It is underlaid by 12 inches of blue shale, and this in turn by alternating layers of blue clayey shale and limestone.

40. *Rofing and Wagner's School House*.—Three and a half miles north of Napoleon, on the road from New Point to Napoleon. In the Creek bed the Clinton is exposed. It is about a foot thick, and has the brownish color seen at Hanover, Indiana. The following fossils were found: *Cyclonema bilix*, ordinary Clinton type, *Orthis calligramma*, var. *euorthis*, *Phænopora expansa*, *Pachydictya bifurcata*, *Clathropora frondosa*, and *Heliolites megastoma*? Below the Clinton was found rock varying in color from bluish like the Cincinnati group, rock, to white, similar to that seen at the New Point quarry, and said to resemble the Dayton stone lithologically but not stratigraphically. Above the Clinton were found two feet of a whitish rock. This rock was in places crinoidal, and at other places more nearly resembled the texture of the Dayton stone. The weathered surfaces of the rock usually showed plenty of crinoidal material. A large pygidium of *Illænus daytonensis* was found in it but this fossil belongs also in the higher horizons. The thin yellowish layers of the magnesian Niagara, such as are seen often near the base of the Laurel bed, were found immediately above. For purposes of correlation this locality should be more carefully investigated.

41. *Napoleon*.—Along the side of a little stream near the house of David L. Eaton, about one and a half miles north of Napoleon, rock is exposed. One layer is crinoidal, whitish, and hard, is 8 inches thick and resembles the crinoidal layer in the creek south of the Rofing and Wagner school-house. In this rock was found a small glabella of *Illænus ambiguus*, but this form is probably identical or at least an immediate forerunner of *Illænus insignis*, in the Niagara; it requires the pygidium to distinguish the species. This rock appears to be the same also as the basal portion of the Laurel bed as exposed in the quarry at the north end of Osgood, where it is also richly crinoidal but carries an undoubted Niagara fauna. If this be the

correct correlation, the Clinton seems at this place to be entirely absent. Immediately over this rock occurs the yellow more magnesian rock often seen at the base of the Laurel bed, but seen also above the level of the crinoidal rock north of the Rofing and Wagner quarry. It will be remembered that at the latter locality the Clinton actually occurred some distance below the crinoidal rock. Possibly at the David Eaton locality the Clinton may be found farther down the creek, though my recollection is that blue clayey shales indicate the presence of the Lower Silurian just below, and suggest the consequent absence of the Clinton. This locality should be more carefully studied.

42. *Osgood*.—Following the railroad north-east, to the border of the town, exposures of the Clinton are found along the hillside lining the southern side of a country road. The Clinton here is 28 inches thick. It has the same brown color shown by the Clinton at Hanover, Indiana. Some distance farther east the Clinton shows near the base inclusions of brecciated and scarcely rounded fragments of a blue clayey stone of the Cincinnati type. I was hardly able in the short time at my command to decide whether these inclusions were to be considered as pebbles. Immediately beneath the Clinton was the Cincinnati formation with *Tetradium* and *Strophomena alternata* var. *fracta*. Above the Clinton was a soft brownish rock; 76 inches above the Clinton occurred a layer of a whitish crinoidal rock, a few inches thick, containing *Atrypa reticularis*. This was undoubtedly the rock corresponding to the crinoidal bed north of Rofing and Wagner's school.

In the Clinton were found *Illænus daytonensis*, pygidium, *Illænus ambiguus*, pygidium, *Plectambonites transversalis* var. *elegantula*, *Orthis calligramma*, Hanover type, *Rhinopora verrucosa*, epithelial layer exposed, and *Heliolites subtubulatus*.

Going to the northern end of the town, a quarry is found on the east side of the road. Here is found a crinoidal whitish rock, stratigraphically the lower part of the Laurel formation (Dayton stone) but differing from usual exposures of this formation in the large number of fossil remains it contains in certain layers. Altogether about 30 inches of this rock are exposed. The Clinton is found in the bed of a small stream a short distance eastward, in the fields. Between the solid white crinoidal rock in the quarry and the Clinton there is room

for the shaly material occasionally found between these beds. In the crinoidal rock at this locality were found *Illæus*, large pygidium like the elongated form of *Ill. ambiguus*, *Dalmanites verrucosus?* pygidium, *Orthoceras*, of the type of *O. annulatum*, *Plectambonites transversalis*, elongated laterally, *Orthis calligramma*, few plications, also var. *fissiplicata*, *Orthis hybrida*, *Meristina nitida*, *Atrypa reticularis*, both forms, with finer, and with coarser plications, *Rhynchonella indianensis?* *Rhynchonella neglecta*, somewhat broader anteriorly than type specimens, *Pisocrinus gemmiformis*, *Stephanocrinus osgoodensis*, *Stephanocrinus cornetti*, similar to figure 10 in the Indiana report describing this species, the radial plates not as straight as in figure 12, *Ceramopora labecula*, with the central cells more oblique, producing a central stellate appearance, not attached to other fossils, *Striatopora gorbyi*, and *Streptelasma* (*Duncanella*) *borealis*.

Going from Osgood south westward down the railroad, another quarry is found about a mile distant from town. Here the upper beds of the Laurel formation contained crinoidal remains as well as the basal portions, as at the quarry north of town. The best beds for crinoidal remains occurred about 9 feet above the base of the quarry, and contained frequent specimens of *Pisocrinus gemmiformis*, and *Stephanocrinus osgoodensis*, as well as a few specimens of *Atrypa reticularis*. It will be remembered that the crinoidal beds in the Dayton limestone in western Ohio are also found in the upper half of the series, and that *Pisocrinus gemmiformis*, and *Stephanocrinus osgoodensis* were found in the quarry of James Carl, about three and a half miles south-west of Lewisburg.

REMARKS SUGGESTED BY RECENT OBSERVATIONS.

Since the foregoing observations were written a number of localities between Osgood and Charlestown, Indiana, were visited. There certainly was no room for the Medina between the top of the Lower Silurian and the base of the Clinton, or (when the Clinton was absent) the base of the Niagara, at these localities. It has become a certainty therefore that the Medina is absent in Indiana and the western line of counties in Ohio. If present in Ohio and actually outcropping, it can be represented only by the Belfast bed, from Adams to Miami counties. The Belfast bed, however, turns westward into a clayey, less solid rock which at times contains or is overlaid by Lower Silurian fossils.

In the southwestern exposures of the Upper Silurian in Indiana recently visited, the Clinton never exceeds $3\frac{1}{3}$ feet in thickness, is usually much thinner, and at several localities has been found entirely absent. Observations so far made suggest that the Clinton once extended across the Cincinnati anticlinal axis in southern Ohio, that it thinned out from 30 to 40 feet at the more eastern exposures in Ohio to less than 4 feet at the more western exposures in Indiana, and that at a number of localities in Clark, Ripley, and probably in Fayette counties in Indiana, the Clinton is entirely absent. Numerous pebbles were found at the base of the Clinton at Osgood and at several localities southwest of Versailles, the extreme localities being 10 miles apart. Evidence is accumulating for the existence of land conditions west of the outcrops of Clinton from Fayette to Clark counties in Indiana. The Clinton, instead of being deposited around an island, the northern end of which extended into Ohio near Cincinnati, has been deposited against land lying west of the line of outcrops in southern Indiana.

From the middle of the western side of Fayette county and the eastern side of Union county in Indiana, the Clinton thickens on going northwards.

The additional observations recently accumulated, and here in part recorded, will form a continuation of the present paper.

NOTE ON THE "CHACHALACA"

Ortalis vetula macalli Baird.

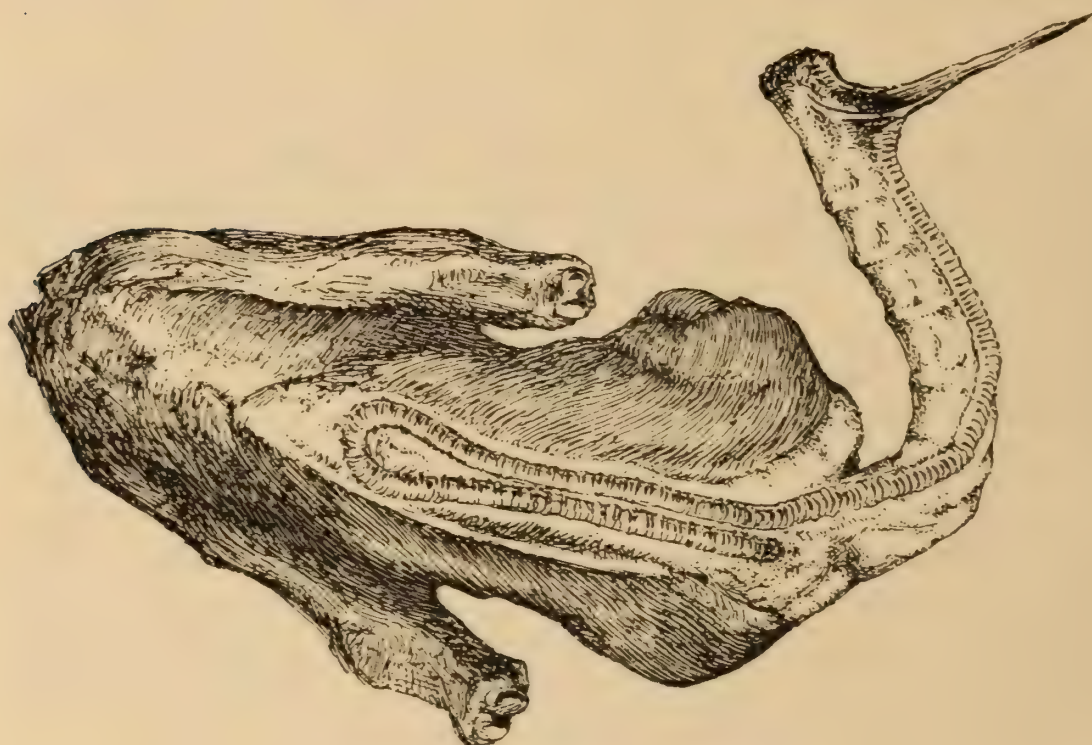
BY CHARLES DURY.

In the Autumn of 1893, the Cincinnati Zoological Garden received from Texas two nearly adult birds of this species. They have been exceedingly healthy in captivity and quickly became tame and friendly with their keeper, whom they soon learned to distinguish from a stranger. During the temporary absence of the regular keeper a strange man went in to clean their cage, when both birds immediately attacked him with great fury, flying up at his face and head. Their food has consisted of cracked corn, soft prepared bird food and chopped beef. They are very inquisitive birds. Alongside of the aviary in which they were confined was another cage containing a group of Leadbeater's Cockatoos. One of the *Ortalis* thrust his head through an opening and was quickly seized by a Cockatoo, who bit off both of his mandibles close up to the nostrils. But this terrible injury did not seem to have any ill effect on the bird as it continued to feed as usual and remained in perfect health.

They sound their loud call notes early in the morning, and keep up a continual scolding when a stranger approaches too closely. March 9, 1896, the birds were suddenly frightened, when one of them dashed itself violently against the wires of the cage, striking its head and killing itself instantly. On dissection the bird proved to be a male. The arrangement of the trachea is very peculiar, passing down between the skin and pectoral muscles on the right side of the keel of the sternum, forming a loop and returning on the same side and passing into the thoracic cavity. In this specimen the trachea was partly surrounded by a pad of fat. The accompanying figure (kindly drawn by Mr. H. P. Ijams) will show it better than I can

describe it. In a letter from Dr. R. W. Shufeldt of Washington, D. C. (just received through Prof. Robt. Ridgway) he says the loop formed by the flexure of the trachea does not extend so far down in the female as in the male. Dr. Shufeldt will shortly issue a paper on the anatomy of this species. This peculiar condition of the trachea of the *Cracide* was probably first described by Yarrell, 1831, and in *La Naturaleza* (Mexico) 1889, p. 278, is a figure (very poor) showing this arrangement, perhaps taken from a female as the tracheal loop does not extend so far down.

This specimen is preserved in the Museum of this Society, No. 8133.



Ortalis vetula maccalli Baird.

$\frac{5}{9}$ N. S.

Index—Volume XVIII.

- Acrothecium recurvatum*, n. sp., 44; Pl. III, fig. 21.
Arcyrioides, 40.
Aecidium berberidis on *Podophyllum*, 47.
Aeschna clepsydra Say, 114.
 constricta Say, 114.
 verticalis Hazen, 114.
Æschninæ, 108.
Agaricus (*Galera*) *lateritius* Fr., 36.
 (*Clytocybe*) *ochro-purpureus*, 46.
Agrioninæ, 105.
Ambrosia trifida, 47.
Amnicola cincinnatiensis, 96.
Amplexopora pustulosa Ulrich, 72.
Amphiagrion saucium Burm, 113.
Anax junius Drury, 110, 114.
Anculosa; *Cincinnati* species of the genus, 97.
Ancylus; *Cincinnati* species of the genus, 96.
Anisopteryx, 149.
Anodonta; *Cincinnati* species of the genus, 103, 104.
Anomalagrion hastatum Say, 106-113.
Anorthite, 61, fig. 1 g.
Anthonomus grandis, 154.
Aralia racemosa at *Cincinnati*, 48.
Argia apicalis Say, 113, 114.
 putrida Hazen, 110, 113.
 sedula Hazen, 113.
 tibialis, 113.
 violacea Hazen, 113.
Argentite, 61, fig. 1 b.
Argynna, gen. nov., 41.
 polyædron (Schw.), 41, Pl. II, fig. 14.
Asimina triloba, the host of a fungus, 43.
Asochyta cornicola Sacc., 50-55.
Asteroidea; fossil of *Cincinnati*, 126.
Asterostroma Masee, 38.
 pallidum, n. sp., 38, Pl. I, fig. 6.
Atactopora hirsuta Ulrich, 78.
 maculata Ulrich, 78.
 tenella Ulr., 79, 80.
Atactopora mundula Ulr., 79, 80.
 multigranosa Ulrich, 79, 80.
Atactoporella multigranosa (Ulr.), 79, 80.
 mundula (Ulr.), 79, 80.
 schucherti Ulrich, 79, 80.
 typicalis Ulrich, 79, 80.
Atrypa marginalis, 171, 193, 196.
 marginalismutistriata, 196.
 reticularis, 198, 199.
Augite, 61, fig. 1 f, Pl. IV.
Autenheimer, F. A., resigned, 1.
Ayres, Ph. W., member, 2.
Azelacrinites, 186.
Bail, H. E., member, 3.
Barnes, Ch., resigned, 4.
Barton, E. H., resigned, 4.
Basiaeschna janata Say, 112, 114.
Bettman, Dr. H. W., member, 2.
Belfast bed of Ohio, 161.
Bigney, Dr. P. M., trustee, 2; deceased, 4.
Blissus leucopterus, distribution in Centr. & N. Am. Pl. V.
Blissus leucopterus, probable origin and diffusion, 141.
Blissus leucopterus, area of greatest abundance in N. A. 148, fig. 1.
Bolbitius radians, n. sp., 36; Pl. I, fig. 1.
Bolinia, 42.
Bovista pila B. & C. 39.
Call, R. E.: Illustrations of little known *Unionidæ*, 157.
Callopora, 119.
 magnipora, 184.
 milfordensis James, 122.
Calloporella (?) *verrucosa* Ulrich, 85.
Calopteryx maculata Beaur, 113.
 æquabilis Say, 113.
Calvatia leiospora, n. sp., 39; Pl. II, fig. 8.
 hesperia, 39; Pl. II, fig. 9.
Calymene niagarensis, 185.
 vogdesi, 167, 169, 171, 195

- Carychium exiguum* Say, 94.
Celithemis eponina Drury, 114.
Ceramopora labecula, 199.
 Nicholsoni James, 122.
Chætetes attritus Nich., 116.
 clathratulus James, 70.
 clavacoideus James, 84.
 compressus Ulrich, 76.
 corticans Nich., 78.
 decipiens Rominger, 73.
 fusiformis Whitfield, 84.
 granuliferus Ulrich, 120.
 petechialis Nich., 86.
 tuberculatus (E. & H.) Nich., 78.
Chondrioderma floriforme Rostf. 56.
Cionella subcylindrica Binn., 93.
Clathropora frondosa, 171, 196, 197.
 Claypole, Prof. E. W., lecture by, 3, 23.
 Clinton bed of Ohio, 161.
 Collier, T. B., Treasurer, 2.
Columnaria, 175.
Columnopora, 174.
Corbiculidæ, 104.
Cordulegaster erroneus Hagen, 114.
 obliquus Say, 108, 114.
Cordulegasterinæ, 108.
Cordulinæ, 108.
Corticium læve (Pers.) Fr., 54.
 Corresponding societies and institutions, list of, 9.
Conophyllum niagarensis, 172, 184.
Constellaria Dana, 117.
 antheloidea Nich., 118.
 fischeri Ulrich, 118.
 florida Ulrich, 118.
 limitaris Ulrich, 118.
 parva Ulrich, 119.
 polystomella Nich., 118.
 Constitution amended, 1.
Cracidæ, 202.
Craniella, 169.
Craterium mutabile Fr., 56.
Cribraria languescens Rex., 57.
 Crystals, artificial, 61, Pl. IV.
Cyathophyllum calycula, 172.
 celator daytonense, 195.
Cyclonema bilix, 184, 197.
Cyclopora Jamesi Prout, 70.
Cylinarosporium (?) *oculatum*, 50, 55.
 viride (?), 50, 55.
Dalmanella elegantula, 167, 169.
Dalmanites werthneri, 193.
 verrucosus, 199.
Dekayella Ulrich, 115.
Dekayia E. & H., 115.
 appressa Ulrich, 117.
 aspera E. & H., 116.
 maculata James, 116.
 multispinosa Ulrich, 116.
 paupera Ulrich, 117.
 pelliculata Ulrich, 117.
Detonia, 43.
Diabrotica, 154.
Diamesopora oweni Ulrich, 120.
Didelphys auritus, habits of, 146.
Didymops transversa Say, 108, 114.
Diphyphyllum cæspitosum. 172, 173, 184.
Diplax assimilata Uhler, 114.
 corrupta Hagen, 109, 114.
 sp. (*D. costifera* Kellicott, not of Hagen,) 112, 114.
 madida Hagen (?), 109, 114.
 obtrusa Hagen, 114.
 rubicundula Say, 114.
 semicineta Say, 114.
 vicina Hagen, 114.
Diplodia zeæ Schw, the host of a fungus, 44.
 Director of Museum, report by, 5.
Dromogomphus spinosus Selys, 111, 114.
 spoliatus Selys, 111, 114.
Drymopora fascicularis, 184, 194.
Duncanella borealis, 199.
 Dury, Ch., curator of zoology, 3.
 "Note on the chachalaca," 201.
 vice-president, 2.
Dystactophycus mamillanum, M. & D., 125.
Echinodermata, fossil of the Cincinnati period, 125.
 Edwards, Prof. Ch. L., member of Ex. Board 2, lecture by, 23.
Enallagma carunculatum Morse, 105, 110, 111, 113.
 civile Hagen, 106, 113.
 divagans Kellicott, 106, 113.
 divagans Selys, 105, 113.
 ebrium Hagen, 113.
 exulans Hagen, 113.
 fischeri Kellicott, 110, 113.

- Enallagma geminata* Kellicott, 106, 113.
hageni Walsh, 105, 113.
pollutum Hagen, 113.
signatum Hagen, 113.
Encrinurus punctatus, 170; sp. 187.
Endoceros, host of Bryozoa, 78.
Enteridium rozeanum (Rost) Wing, 57.
Epiæschna heros Fabr., 114.
Epicordulia princeps Hagen, 114.
Erythromma conditum Hagen, 105, 113.
Exoascus pruni on *Prunus americana*, 50.
Favosites favosideus, 172, 186.
favosus, 184, 186, 192, 195, 196.
niagarensis, 167, 170, 171, 173, 193, 194.
venustus, 172, 196.
Fistulipora McCoy, 119.
flabellata Ulrich, 122.
granulifera (Ulrich), 120.
milfordensis James, 122.
multi-pora James, 121, 122; fig. 12 i.
nicholsoni (James), 121; fig. 12 a-c.
oweni James, 119.
rustica (Ulrich), 120.
siluriana James, 121, 122; fig. 12 d-h.
venusta, 121.
 Foerste, Aug. F. The middle Silurian rocks of Ohio and Indiana, 161.
Fonscolombia vinosa Say, 111, 114.
 French, Dr. T. H., Jr., curator of physics, 3.
Fuligo ellipsospora Lister, 56.
 Fungi, New North American, by A. P. Morgan, 36.
Fusisporium culmorum W. Sm., 51, 55.
 Gasteropoda of the Cincinnati region, by Harper, 89.
Geaster minimus Schw., 55.
velutinus, n. sp., 38; Pl. I, fig. 7.
Gomphæschna furcillata antilope Hagen, 108, 114.
 Gomphinae, 106.
Gomphus dilatatus Rambur., 106, 111, 113.
Gomphus exilis Selys, 111, 113.
externus Selys, 107, 111, 113.
fraternus Say, 111, 113.
fraternus walshii Kellicott, 107, 108, 111, 113.
furcifer Hagen, 108, 111, 113.
graslinellus Walsh, 111, 113.
spicatus Selys, 111, 113.
spiniceps Walsh, 111, 114.
vastus Walsh, 111, 113.
villosipes Selys, 108, 111, 113.
 Goniobasis; Cincinnati species of the genus, 97.
 Grimsley, Dr. G. P.: "Mineral Synthesis," 58.
Guignardia bidwellii (Ellis) Viala & Rav., 55.
Gymnosporangium clavipes C. & P., 55.
Gyraulus parvus Say, 95.
Hagenius brevistylus Selys, 107, 111, 113.
Halysites catenulatus, 186, 170, 171, 172, 180, 181, 184, 168, 165, 167, 189, 193, 194, 196.
 Harper, Prof. Geo. W., vice-president, 2; curator of geology, 3.
 Harper, Geo. W., Catalogue of Land and Fresh Water Shells found in the vicinity of Cincinnati, 89.
 Harrison, C. L., resigned, 2.
 Hayes, Seth, member, 1; librarian, 3.
Hebertella daytonensis, 167.
Helicodiscus lineatus Say, 93.
 Heliolites, 177.
megastoma, 167, 192, 197.
subtubulatus, 180, 181, 184, 192, 193, 195, 196, 198.
 Helisoma; Cincinnati species of the genus, 95.
Helvella elastica Bull.; the host of a fungus, 45.
Hemitrypa ulrichi, 170, 171, 172, 180, 186, 196.
Hemiarcyria montana, n. sp., 40; Pl. II, fig. 12.
Hetærina americana Fabr., 113.
Heterotrypa Ulrich, 115.

- Heterotrypa inflecta* Ulrich, 77.
 prolifera Ulrich, 75.
 singularis Ulrich, 77.
 vaupeli Ulrich, 72.
 Hickorywood, the host of a fungus, 41, 42.
Homotrypa curvata Ulrich, 71.
 flabellaris Ulrich, 75.
 obliqua Ulrich, 124.
 contexta Ulrich, 74.
 granulifera Ulrich, 120.
 rustica Ulrich, 120.
 Human skeleton from Linwood, 6.
Hyalina; Cincinnati species of the genus, 91 and 92.
Hydnum atro-viride n. sp., 38; Pl. I, fig. 5.
 pallidum, C & E., 54.
Hymenochæte imbricata (Schw.), Liv., 54.
Hypomyces xylophilus, 49.
Hysterium rousselli (De Noti) acc., 55.
Illænus ambiguus, 171, 193, 197, 198, 199.
 daytonensis, 171, 172, 176, 181, 184, 193, 195, 197, 198.
 insignis, 197.
 Indiana, middle silurian rocks of, by Foerste, 161, Pl. VII.
Irpex paradoxus (Schrader) Fries, 54.
Ischnodemus falicus Say, 151.
 præculatus, 151.
Ischnura verticalis Say, 110, 113.
Isosoma tritici, 149.
 James, D. L., President, 2.
 James, Jos. F., Manual of the Paleontology of the Cincinnati Group, parts VI and VII, 2, 67, 115.
 James, Jos. F., Remarks on "A catalogue of Ohio plants," by Kellerman and Werner, 46.
 Johnson, G. C., resigned, 2.
 Kelley, T. H., Secretary, 2; Trustee, 4.
 Kellicott, D. S., Catalogue of the Odonata of Ohio, part II, 105.
 Labradorite, 61; Pl. IV.
Læstadia bidwelli Ellis, 55.
 Lectures, program of the 15th course, 23.
Leioclema wilmingtontense Ulrich, 77.
Lentinus, 37.
 tigrinus Bull 37.
Lentodium, gen. nov., 36.
 squamulosum, n. sp., 37; Pl. I, fig. 3.
Leptæna rhomboidalis, 171, 177, 193, 196.
Leptotrypa clavis Ulrich, 82.
 cortex Ulrich, 82.
 minima Ulrich, 84.
 ornata Ulrich, 82.
 stidhami Ulrich, 76.
Lestes congener Hagen, 105, 113.
 disjuncta Selys, 113.
 forcipata Ramb, 113.
 inæqualis Walsh, 110, 113.
 rectangularis Say, 113.
 uncata Kirby, 113.
 unguiculata Hagen, 113.
 vigilax Selys, 110, 113.
Leucite (and *leucite tephrite*) 60, 61, fig. 1 C; 64, Pl. IV.
Leucochila; Cincinnati species of the genus, 93, 94.
Leucorrhinia intacta Hagen, 114.
Libellula auripennis Burm, 114.
 basalis Say, 114.
 quadrifasciata Linné, 114.
 pulchella Drury, 114.
 semifasciata Burm, 112, 114.
 (*axillena*) *vibrans* Fab., 109, 114.
Libellulidæ, 109.
 Library, duplicates in the, 24.
Lichas breviceps, 171.
Limax; Cincinnati species of the genus, 89.
Limnæa; Cincinnati species of the genus, 95.
Lioplax subcarinata Say, 96.
 Lloyd, C. G., member of Board, 2; Curator of Botany, 3.
 Lloyd, Prof. J. U., member, 2; curator of chemistry, 3.
 Lord, N. W., lecture by, 23.
Lycogala repletum n. sp., 40; Pl. II, fig. 13.
Lycoperdon dryinum n. sp., 39; Pl. II, fig. 10.
 pusillum, 40.
Macrocyclus concava Say, 93.
Macromia illinoiensis Walsh, 108, 112, 114.
 tæniolata Ramb., 114.
 Magnetite, 61; Pl. IV.

- Marasmius melanopus* n. sp., 36; Pl. I, fig. 2.
ramealis Bull., 54.
Margaritana; *Cincinnati* species of the genus, 103.
Mastodon remains donated by Miss Shaw, 5.
Medina beds in Ohio, 161.
Melantho; *Cincinnati* species of the genus, 96.
Meristella umbonata, 171, 192.
Mesodon; *Cincinnati* species of the genus, 89, 90.
Mesothemis simplicicollis Say, 114.
Mineral synthesis, by G. Perry Grimsley, 58.
Mitrula roseola n. sp., 42; Pl. III, fig. 16.
Mollusca found in the vicinity of *Cincinnati*, list of the, 89.
Moorehead, W. C., curator of anthropology, 3.
Monotospora nigra n. sp., 44; Pl. III, fig. 20.
Monticulipora (*Dekayia*) *aspera*, E. & H., 116.
aspera (Ulr.), 82, 83.
asperula (Ulr.), 81.
calceola, M. & D., 87.
cincinnatiensis, 85.
clavacoides James, 84.
cleavelandi James, 68.
clintonensis James, 73.
compressa (Ulr.), 75.
consimilis Ulr., 85.
contexta (Ulr.), 74.
crustulata (James), 82, 83.
cumulata (Ulr.), 74.
curvata (Ulr.), 71.
dawsoni Nich., 68.
dycheri James, 83.
flabellaris (Ulr.), 75.
frondosa D'Orb., 72.
fusiformis (Whitfield), 83.
Group I, massive species (?), 124.
Group IV laminar or frondescant, 67.
Group V incrusting or parasitic, 78.
Group VI apparently free, of
Monticulipora anomalous shape 87, 115.
hamiltonense James = *M. winchelli* Ulrich, 87.
hospitalis neglecta, James & James, 124.
hospitalis Nich., var. of *selwynii*, 86, 87.
inflecta (Ulr.), 77.
laevis Ulr., 85.
lamellosa Ulr., 83.
maculata James, 116; fig. 11.
mammulata, 68, 69, 70.
(*Fistulipora*) *milfordensis* James, 122.
molesta Nich., 68.
neglecta, var. of *hospitalis*, 124.
(*Fistulipora*) *Nicholsoni* (James) 121; fig. 12.
nodulosa, 85.
ortoni Nich., 79, 80.
(*Fistulipora*) *oweni* James, 119.
papillata (McCoy) 81.
parasitica Ulrich, 81.
parva Ulrich, 119.
pavonia (D'Orb.), 70.
pelliculata Ulr., 117.
petechialis (Nich.), 85.
(*Constellaria*) *polystomella* Nich., 118.
prolifera (Ulr.), 75.
pustulosa (Ulr.), 72.
rustica (Ulrich), 120.
selwynii (Nich.) 86.
var. *hospitalis* Nich., 86, 87.
singularis (Ulr.), 77.
stidhami (Ulr.), 76.
subcylindrica U. P. James, n. sp., 123.
subfusiformis James 84.
tuberculata (E. & H.), 78.

- Monticulipora turbinata* James, 86.
uniformis (Ulr.) 76.
varians, 74.
vaupeli (Ulr.), 71, 74.
venusta, 120.
verrucosa (new name), 85.
wilmingtonense (Ulr.), 76.
winchelli Ulr., 87.
winchelli James, 87.
rectimuralis Ulr., 124.
undulata Nich., 124.
 Morgan: "New North American Fungi," 36.
Mucronoporus spissus, 50.
 Murdock, James, member, 3.
Murgantia histrionica, 141, 153.
munda, 153.
Mycogone cervina Ditm., 45.
cinera, n. sp., 45; Pl. III, fig. 24.
Myriadoporus adustus, 49.
Myxomycetes, 41, 42.
Nebulipora papillata McCoy, 81.
Nehalennia gracilis Morse, 110.
irene Hagen, 110, 113.
posita Hagen, 113.
Nelumbo lutea (Willd.) Pers., 54.
Nephelite, 61; fig. 1d.
Nicholsonella cumulata Ulrich, 74.
vaupeli (Ulr.), 72.
 Norton, Dr. O. D., member of Ex. Board, 2.
Obliquaria cyphya Rafinesque, 158.
Odonata of Ohio, by Kellicott, 105.
 Officers elected, 3.
 Ohio: Middle Silurian rocks of. By Foerste. 161; Pl. VII.
Olivine, 61; fig. 1e, Pl. IV.
Ophiuroidea, 137.
Orgyia, 149.
Ortalis vetula macalli Baird, 201.
Orthis biforata, 165, 169, 172, 182, 186, 187, 192, 193, 195.
biforata daytonensis, 172.
calligramma, 169, 171, 192, 193, 194, 196, 198, 199.
euorthis, 197.
fissaplicata, 199.
hybrida, 199.
daytonensis, 167.
elegantula, 167, 169, 179, 180, 184, 186, 193.
fausta, 179.
fissiplicata, 184.
Orthis occidentalis, 165, 174, 178, 180, 182, 184, 186, 187, 193, 195.
Orthoceras sp., 182, 193.
annulatum, 199.
 host of Bryozoa, 78, 79.
 Orton, Edw., Jr., lecture by, 23.
Oxybaphus nyctagineus Sweet, 54.
Pachydictya bifurcata, 171, 181, 194, 197.
instabilis, 180.
obesa, 171, 195.
rudis, 184, 193.
turgida, — P. *obesa*, branching form, 171, 186.
Pachydiplax longipennis Burm, 114.
 Palæaster Hall, 126.
antiquatus (Locke), 130.
antiquus (Troost), 133.
clarkanus S. A. Miller, 133.
dubius M. & D., 130.
dyeri Meek, 128.
exsculptus S. A. Miller, 129.
finei Ulrich, 130.
granulosus Hall, 128.
harrisi S. A. Miller, 137.
incomptus Meek, 133.
jamesii Dana, 127.
longibrachiatus S. A. Miller, 132.
magnificus, S. A. Miller, 127.
miamiensis S. A. Miller, 129.
shæfferi Hall, 131.
simplex M. & D., 132.
sp., 186.
speciosus (M. & D.), 131.
spinulosus M. & D., 129.
Palæasterina (McCoy) Salter, 126, 135.
approximata M. & D., 133.
jamesii Dana, 127.
 Palæontology of the Cincinnati Group, 67, 115.
Pantala flavescens Fabr, 112, 114.
hymenæa Say, 109, 114.
Paspalum distichum, 152.
 Patrick, Miss E. M., member, 2.
Patula; Cincinnati species of the genus, 91.
Pentamerus oblongus, 185, 188.
Perichæna populina Fr., 57.
Perithemis domitia Drury, 110, 114.

- Peronopora compressa* (Ulr.), 76.
 uniformis Ulrich 76.
Petigopora asperula Ulrich 82.
 gregaria Ulrich, 124.
 petechialis (Nich.), 86.
Petraster Billings, 126, 134.
 rigidus, 134.
 wilberanus Meek, 134.
Peziza nigrans n. sp., 43; Pl. III,
 fig. 17.
 trachycarpa Currey, 43.
Phacops trisulcatus, 169.
Phænopora sp., 177.
 expansa, 171, 178, 197.
 magna, 171, 178, 181.
 Photographic section, curator's
 report, 33.
Phylloporina angulata, 170, 171,
 172, 180, 186, 193, 196.
Physa; Cincinnati species of the
 genus, 95.
Physarum didermoides Rost., 56.
 globuliferum Pers., 56.
 inequale Peck, 56.
 cucopus Link, 56.
 mellum Mass, 56.
 multiplex Peck, 49, 56.
 murinum Lister, 56.
 polyædron Schw., 41.
 pulcherrimum Besk &
 Rav., 56.
 pulchripes Peck, 56.
 tenerum Rex., 56.
Physospora elegans n. sp., 44; Pl.
 III, fig. 23.
Pisidium abditum Hald., 104.
Pisocrinus gemmiformis, 185, 191,
 199.
Planorbis; Cincinnati species of
 the genus, 95.
Plasmodiophora brassicæ Wor., 55.
Plathemis trimaculata De Geer.,
 114.
Platyceras niagarens, 179, 180.
Platystoma niagarens, 179, 180.
Platystrophia biforata, 165, 167,
 169, 172, 182, 187, 192, 193.
Plectambonites sericea, 195.
 transversalis 199.
 elegantula, 168, 195,
 198.
Pleurocera; Cincinnati species of
 the genus, 97.
Podophyllum peltatum, the host
 of two fungi, 47.
Polypodium incanum, 47.
Polyporus circumstans n. sp., 37;
 Pl. I, fig. 4.
Polyporus delectans, 49.
 pinicola Fr., 37.
Polystictus perennis (L.) Fr., 54.
Pomatiopsis lapidaria, 97.
Poria tulipiferæ Schw., 54.
Prasopora selwynii Nich., 86.
 hospitalis, 86.
 simulatrix (Nich.), 86.
 Proceedings of meetings, 1, 3, 4.
Protaster Forbes, 137.
 flexuosus M. & D., 140.
 (?) *granuliferus* Meek, 138.
 miamiensis Miller, 138.
Protasterina fimbriata Ulrich, 139.
 flexuosa (M. & D.), 140.
Ptilodictya lanceolata americana,
 171, 179.
 pavonia D'Orb., 70.
Ptychophyllum ipomæa, 167, 180,
 181, 184, 195.
Puccinia on *Podophyllum*, 47.
Punctum minutissimum Lea, 93.
 Punshon, Thos. B., donated human
 remains from Linwood, 6.
 Pupa; Cincinnati species of the
 genus, 93, 94.
Pyrenomycetes, 42.
Pyrenomyxa gen. nov., 42.
 invocans n. sp., 42;
 Pl. II, fig. 15.
Quercus macrocarpa, acorns of, 47.
Ranunculus abortivus micranthus
 Gray, 54.
 repeus L., 54.
 Reed, Dr. Ch. A. L., member, 4.
Reticularia, 41.
 nitens n. sp., 40; Pl.
 II, fig. 11.
 atra, 40.
 Resor, C., member, 3.
Rhinodictya (?) *rudis*, 184.
Rhinopora verrucosa, 171, 176, 177,
 180, 184, 186, 192, 193, 195, 196,
 198.
Rhynchonella acinus, 169;
 convexa, 169.
 indianensis, 199.
 neglecta, 199.
 scobina, 176, 179,
 180.
 Ricketts, Dr. B. M., member of
 Board, 2.
Rudbeckia hirta, depauperate spec-
 imen, 48.
Rutile, artificial crystal of, 61; fig.
 1a.
Secotium, 37.
Segmentina armigera Say, 95.

- Septoria consimilis*, 52.
 leptostachya E. & K., 49, 55.
 wilsoni Clinton, 55.
Scleroderris rubra, n. sp., 43, Pl. III, fig. 18.
 Shaw, Miss Louise, donated remains of mastodon, etc., 5.
Shepperdia argentea Nutt., the host of a fungus, 37.
 Shipley, E. E., curator of photography, 3.
 Silurian rocks of Ohio, the middle, 161.
 Silurian rocks of Ohio and Indiana, the upper, 162.
Somatogyrus; Cincinnati species of the genus, 96, 97.
Spatiopora aspera Ulrich, 82.
 lineata Ulrich, 82.
 maculosa Ulrich, 82.
 montifera Ulrich, 78.
Sphærium; Cincinnati species of the genus, 104.
Sporotrichum globuliferum, 150.
 Springer, Dr. A. A., member, 2; curator of microscopy, 3.
Spumaria alba D. C., 57.
Stellipora limitaris Ulrich, 118.
Stenaster Billings, 126, 135.
 grandis Meek, 136.
 harrissi S. A. Miller, 136.
Stenotrema; Cincinnati species of the genus, 91.
Stephanocrinus cornetti, 199.
 osgoodensis, 185, 191, 199.
 Stickney, Miss L., member, 2.
Strepomatidæ, 97.
Streptelasma borealis, 199.
Streptothrix cinerea, n. sp., 214; Pl. III, fig. 22.
Striatopora flexuosa, 184, 193.
 gorbyi, 199.
Strobila labyrinthica Say, 93.
Stromatopora, 174, 175.
Strophomena alternata, 187, 195.
 Bryozoa on, 79, 86.
 fracta, 187, 195, 198.
 flitexta, 187, 195.
 hanoverensis, 196.
 patenta, 171, 176, 181, 186, 192, 193.
 planumbona, 195.
 tenuis, 171.
Succinea; Cincinnati species of the genus, 94.
Symphynota; Cincinnati species of the genus, 98.
Syringopora fascicularis, 184, 194.
Tæniaster Billings, 138.
 elegans Miller, 139.
Tebennophorus carolinensis Bosc, 89.
Tetradium, 165, 166, 174, 175, 182, 186, 187, 198.
Tetragoneuria cynosura Say, 112, 114.
 semiaquea Burm, 109, 114.
Thelephora caryophyllea (Schæff) Pers., 54.
Trachea of *Ortalis vetula*, 201; fig.
Tramea carolina Linné, 114.
 lacerata Hagen, 112, 114.
 Treasurer's report, 32.
Tremella foliacea Fr., 55.
Triposporium bicornis, n. sp., 43; Pl. III, fig. 19.
Triodopsis; Cincinnati species of the genus, 90.
 Trustees report, 31, 35.
Tryblidiella pygmæa E. & E., 51, 55.
Tubulina cylindrica Bull, 42.
Tyloderma fragariæ, 149.
Unio æsopus Green, 157, 159; Pl. VI.
 Cincinnati species of the genus, 98-103.
 coccineus Lea, 157.
 cyphya Rafinesque, 158.
 ellipsis Lea, 157.
 rubiginosus Lea, 157.
Urasterella McCoy=*Stenaster* Billings, 135, 136.
Ustulina, 42.
Vallonia; Cincinnati species of the genus, 91.
Valvata tricarinata Say, 96.
Vertigo; Cincinnati species of the genus, 94.
Viola cucullata, 49.
Viviparidæ, 96.
 Webster, F. M.: Origin and Diffusion of *Blissus leucopterus* and *Murgantia histrionica*, 141-155.
 Woodpeckers on the Pampas, habits of, 146.
Zea mays, the host of a fungus, 44.
Zonites; Cincinnati species of the genus, 91, 92.

EXPLANATION OF PLATE I.

1. *BOLBITIUS RADIANUS*.

- a.* Pileus and stipe natural size.
- b.* Spores x 500.

2. *MARASMIUS MELANOPUS*.

- c.* Pileus and stipe natural size.
- d.* Section of pileus.
- e.* Spores x 500.

3. *LENTODIUM SQUAMULOSUM*.

- f.* Pileus and stipe natural size, two figures.
- g.* Section of pileus and stipe.
- h.* Spores x 500.

4. *POLYPORUS CIRCUMSTANS*.

- i.* Pileus natural size.
- k.* Section of the pileus.

5. *HYDNUM ATROVIRIDE*.

- l.* Pileus natural size.
- m.* Spores x 500.

6. *ASTEROSTROMA PALLIDUM*.

- n.* Hymenium natural size.
- o.* Stellate hyphæ x 500
- p.* Spores x 500.

7. *GEASTER VELUTINUS*.

- q.* Peridium natural size.
- r.* Threads and spores x 500.

N. B.—The plate is reduced one-third from the drawing.



EXPLANATION OF PLATE II

8. CALVATIA LEIOSPORA.

- a.* Section of peridium showing gleba and sub-gleba
- b.* Threads and spores x 500.

9. CALVATIA HESPERIA

- c.* Peridium natural size.
- d.* Threads and spores x 500.

10. LYCOPERDON DRYINUM.

- e.* Peridium natural size.
- f.* Section of peridium.
- g.* Threads and spores x 500.

11. RETICULARIA NITENS.

- h.* Fragments of walls of sporangia x 40.
- i.* Spores x 500.

12. HEMIARCYRIA MONTANA.

- k.* Portion of thread of the capillitium x 500.
- l.* Spores x 500.

13. LYCOGALA REPLETUM.

- m.* Portion of internal membrane x 40.
- n.* Three short free tubules.

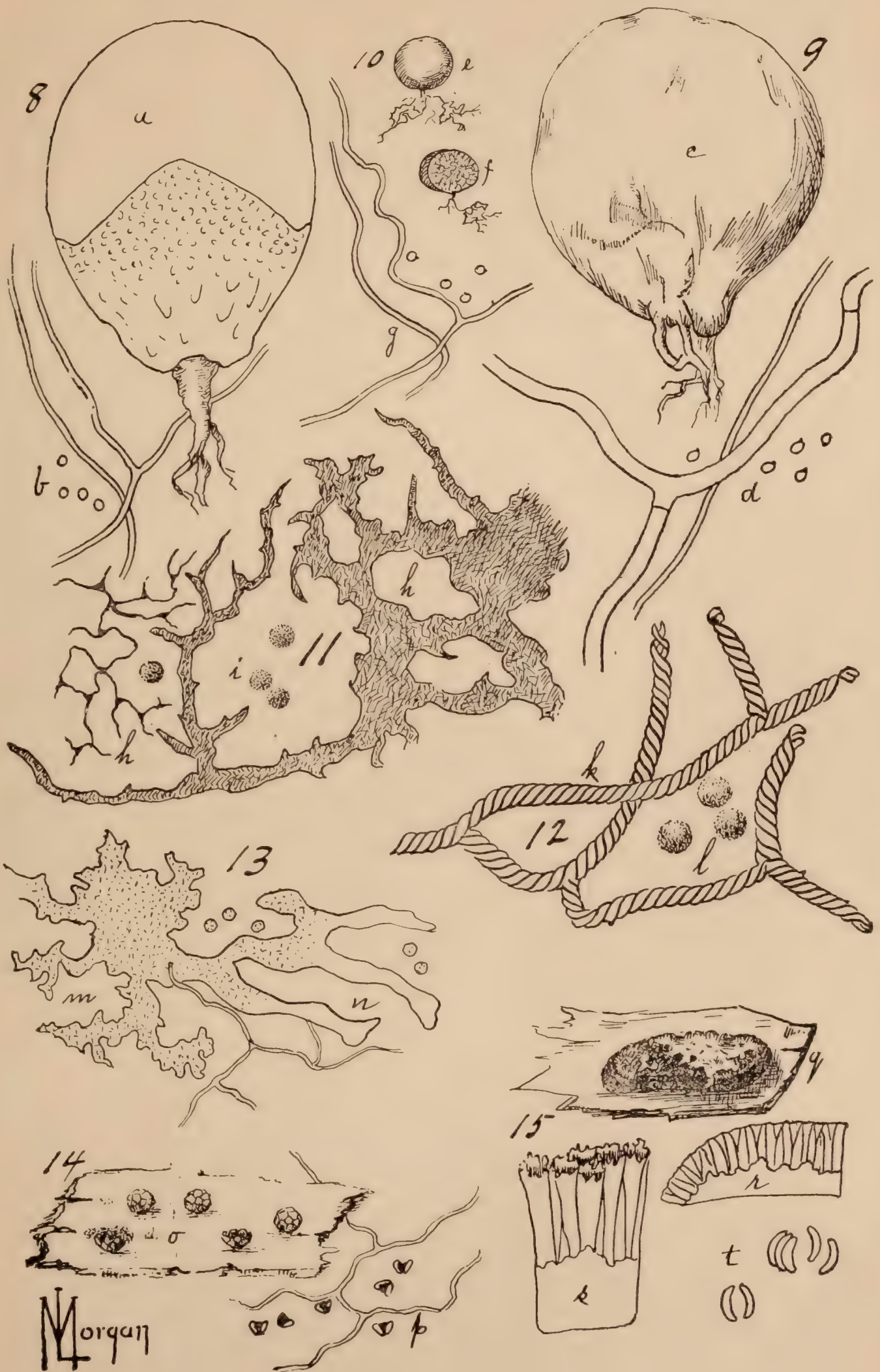
14. ARGYNNA POLYÆDRON, SCHW.

- o.* Perithecia x 10.
- p.* Thread and spores x 500.

15. PYRENOMYXA INVOCANS.

- q.* Stroma natural size.
- r.* Section of the stroma and cells x 40.
- s.* Another section x 10.
- t.* Spores x 500.

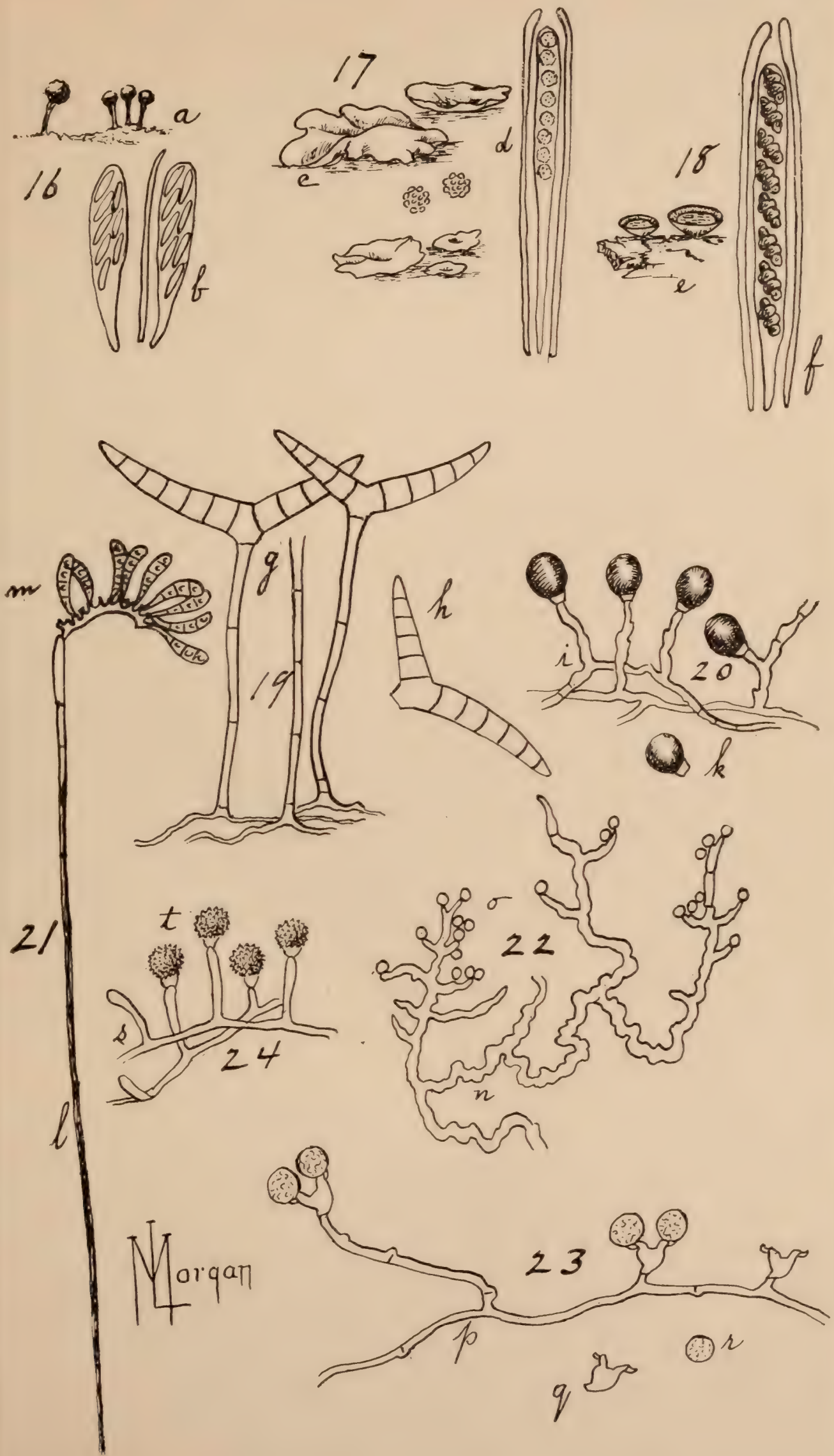
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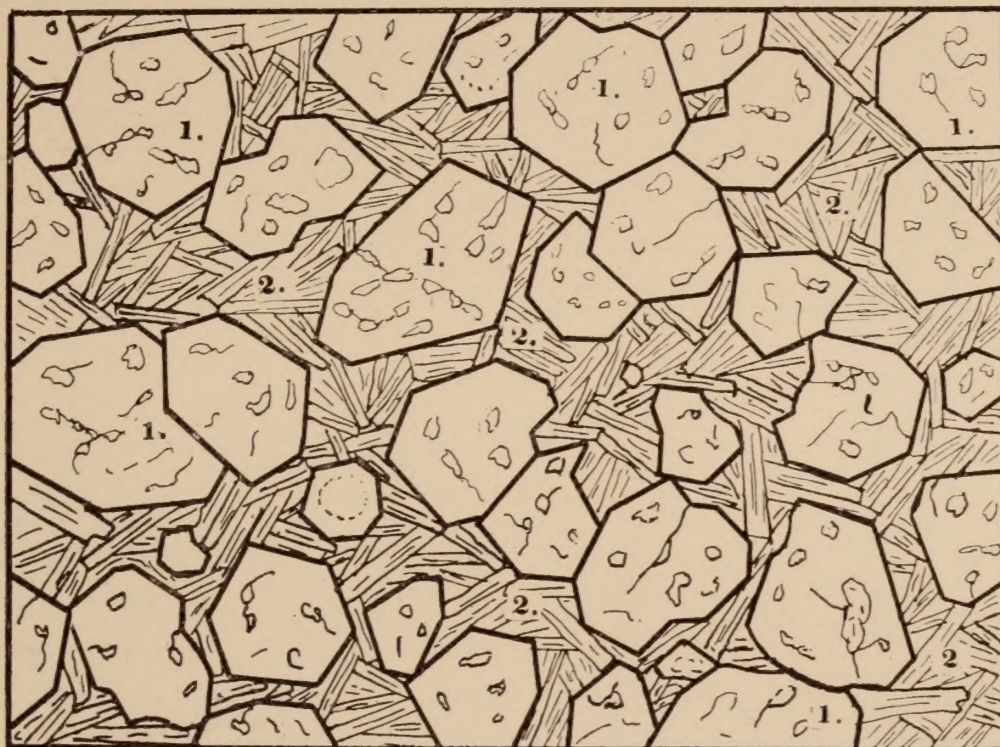
EXPLANATION OF PLATE III.

16. MITRULA ROSEOLA.
 a. Ascoma natural size.
 b. Ascus, paraphyses and spores x 500.
17. PEZIZA NIGRANS.
 c. Ascoma natural size.
 d. Ascus, paraphyses and spores x 500.
18. SCLERODERRIS RUBRA.
 e. Ascomata slightly enlarged.
 f. Ascus paraphyses and spores x 500.
19. TRIOSPORIUM BICORNE.
 g. Fertile branches with spores x 500.
 h. A spore broken off x 500.
20. MONOTOSPORA NIGRA.
 i. Fertile branches bearing spores x 500.
 k. Spore broken off.
21. ACROTHECIUM RECURVATUM.
 l. Fertile hypha x 500.
 m. Spores x 500.
22. STREPTOTHRIX CINEREA.
 n. o. Hyphæ and spores x 500.
23. PHYSOSPORA ELEGANS.
 p. Hyphæ x 500.
 q. Sporophore x 500.
 r. Spore x 500.
24. MYCOGONE CINEREA.
 s. Hyphæ x 500.
 t. Spores x 500.

N. B.—The plate is reduced one-third from the drawing.



LEUCITE TEPHRITE



BASALT.



- | | |
|-----------------|-------------|
| 1. LEUCITE. | 3. OLIVINE. |
| 2. LABRADORITE. | 4. AUGITE. |
| 5. MAGNETITE. | |

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